

SIGNAL SECTION ADVANCE NOTICE

ASSOCIATION OF AMERICAN RAILROADS

PUBLISHED BY THE SIGNAL SECTION, A.A.R., 59 EAST VAN BUREN STREET, CHICAGO 5, ILL.
SUBSCRIPTION: \$3 AND \$6 PER ANNUM.

Vol. XLVIII

No. 1

REPORTS

to be presented at the
Fifty-third Annual Meeting
CHICAGO, ILL.

September 10, 11 and 12, 1951

RULES OF ORDER

RESULT OF 1950 LETTER BALLOT

PRINTED IN U. S. A.

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ASSOCIATION OF AMERICAN RAILROADS
SIGNAL SECTION

COMMITTEE REPORTS

1950 Fiscal Year
(September 20, 1950—September 12, 1951)

Fifty-Third Annual Meeting
Edgewater Beach Hotel
Chicago, Ill.

September 10, 11 and 12, 1951

ASSOCIATION OF AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT

ENGINEERING DIVISION

SIGNAL SECTION

Office of the Secretary, 59 East Van Buren Street, Chicago 5, Ill.

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Signal Section A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on the economics of railway signaling.

The Committee submits for consideration, reports on the following subjects**:

3. Costs involved in stopping trains.

Economics of "off track" equipment.

Economics of automatic, auto-manual, and manual-controlled highway crossing protection devices.

Formula for estimating train miles saved due to increased tonnage with centralized traffic control.

Effect of various classes of track on taxation.

Train hour value.

Grade and tonnage signals.

Highway grade crossing protection.

Car retarders.

Manually operated interlockings.

Automatic interlockings.

Consolidation of interlockings.

Remote control.

Automatic block signals.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

Economical train performance on single track including train capacity on single track.

Electric lighting of signal and switch lamps.

Train operation by signal indication.

Centralized traffic control.

Spring switches.

Removal of Conclusions and Findings from Manual Part 103.

Track and roadway maintenance expenses—per equated track mile.

Operating advantages of centralized traffic control.

Operating advantages of interlocking installation at Fostoria, Ohio, on the New York Central R.R.

COSTS INVOLVED IN STOPPING TRAINS

Introductory.

Previous reports have been presented on Costs Involved in Stopping Trains.* The trains considered in those reports were hauled by locomotives of the reciprocating steam engine type burning coal or fuel oil.

During recent years, the Diesel engine has proved a commercial success in many fields of transportation and through the electrical transmission of power from the prime mover (Diesel engine) to the driving wheels the Diesel-electric locomotive has been made available for use in railroad service and adopted by many railroads.

The trend toward the use of Diesel-electric powered locomotives necessitated the development of something concrete and authoritative on the costs involved in stopping trains when hauled by such type of locomotive, particularly for use in the study of economics of railway signaling and economical operation.

The Committee was fortunate in being able to obtain the assistance of Mr. G. J. Kamat, a graduate student of the College of Engineering of the University of Illinois, working under the very capable direction of H. J. Schrader, Research Professor of Theoretical and Applied Mechanics. Without this help, the Committee would have been unable to produce a report in the short time it has taken to do so.

The study has been completed and the working data comprise 85 pages tabulating the results of calculations, plus 124 pages of graphic charts, and from these data a condensed report has been prepared.

The Committee is indebted also to the companies who furnished engineering data and constructive comments on the many problems met, also to the consulting members of Committee I who have so unstintingly contributed their time and knowledge in checking and proving the procedure and computations required in developing the condensed report herein presented.

The main factor in the costs involved in stopping trains is the cost of the extra fuel required to bring the train up to the speed from which the stop was made, which extra fuel is the fuel wasted account of the stop. This is particularly true in the case of the steam locomotive if braking is done with open throttle, in which event the cylinders are filled with steam the same number of times throughout the braking distance as would be the case when running through the same distance at constant speed. It is also true when braking, that longer intervals of time elapse for filling the cylinders with steam before cut-off occurs. It is general practice to ease off on the throttle gradually as the speed decreases and to shut steam off entirely just before the stop occurs; however, since fuel is being consumed in the firebox at approximately the same rate, no appreciable reduction in fuel consumed is realized during braking. The Committee points out that in braking the Diesel-electric locomotive the Diesel engine is throttled down to idling speed and the difference in the amount of fuel consumed braking and in running through the braking distance at constant speed may be appreciable, depending upon the grade. It has therefore been included in calculating the fuel consumed and wasted account of the stop cycle.

* A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 6 and 317.

In reports previously published in the Proceedings of the Signal Section, the miscellaneous costs involved in stopping trains, such as lubricating oil, brake shoe wear, rail wear and various intangibles have been considered and reported upon, and are therefore not considered in this report.

The amount of fuel wasted account of making a stop is the only factor dealt with and presented in the following report.

In the report, under "Procedure," the Committee has shown all the factors considered in making the study, breaking each factor down into its components, in an endeavor to show that all the essentials in arriving at the amount of fuel wasted account of making a stop have been considered.

It is not feasible to show the computations for all the trains, grades and speeds considered; therefore, as information, following the section on "Results," a typical example and a set of computations are shown.

Train consist.

Trains considered were assumed to have consists as follows:

Number of locomotive units	Number of cars	Trailing tons	Total tons
3	40	2,000	2,345
4	60	3,000	3,460
4	80	4,000	4,460
4	100	5,000	5,460
4	120	6,000	6,460
4	140	7,000	7,460
4	160	8,000	8,460

Each car was assumed to have a light weight of 22 tons, and a gross weight of 50 tons.

Each Diesel-electric locomotive unit was assumed to weigh 115 tons, and deliver 1,500 horsepower.

Grades and speeds.

Stops were assumed to be made on tangent level track and on tangent grades as follows:

+0.2%	+0.4%	+0.6%	+0.8%	(up grade)
-0.2%	-0.4%	-0.6%	-0.8%	(down grade)

at initial speeds of 20 miles per hour and at increments of 5 miles per hour either up to about the balancing speed or up to a speed of 60 miles per hour.

Procedure.

The study was performed by computing the following:

1. The Stopping Distance, by taking into consideration:
 - (a) Braking Ratio of the locomotive.
 - (b) Braking Ratio of the cars.
 - (c) Relations between the Brake Shoe Pressure and the Average Tangential Pull for standard brake shoes acting on Chilled Car Wheels and acting on Steel Wheels.
 - (d) Retarding Force for the locomotive.

- (e) Retarding Force for the cars.
 - (f) Average Retardation.
 - (g) Change in Kinetic Energy.
 - (h) Safety Factor.
2. The Braking Time, by taking into consideration the same elements as in Item 1.
3. The Acceleration Time, by taking into consideration:
- (a) Tractive Force vs. Speed of a Diesel-electric locomotive unit.
 - (b) Number of locomotive units.
 - (c) Train Resistance vs. Speed.
 - (d) Grade Resistance (when applicable).
 - (e) Total Train Resistance (locomotive included).
 - (f) Total Net Pull available for accelerating the train.
 - (g) Acceleration.
4. The Acceleration Distance, by taking into consideration the same elements as in Item 3.
5. The Fuel Consumption During Braking, by taking into consideration:
- (a) Braking Time.
 - (b) Fuel Consumption Rate at No Load.
6. The Fuel Consumption During Standing, by taking into consideration:
- (a) Standing Time.
 - (b) Fuel Consumption Rate at No Load.
7. The Fuel Consumption During Acceleration, by taking into consideration:
- (a) Acceleration Time.
 - (b) Fuel Consumption Rate at Full Load.
8. The Fuel Consumption Running Through, by taking into consideration:
- (a) Braking Distance.
 - (b) Acceleration Distance.
 - (c) Running Through Speed.
 - (d) Running Through Speed Load
- $$= \frac{\text{Train Resistance at Running Through Speed}}{\text{Tractive Force at Running Through Speed}}$$
- (e) Fuel Consumption Rate at Running Through Speed Load.
9. Fuel Wasted Making Stop, by taking into consideration:
- (a) Fuel Consumption During Braking.
 - (b) Fuel Consumption During Standing.
 - (c) Fuel Consumption During Acceleration.
 - (d) Fuel Consumption Running Through.

Since the cost of Diesel fuel varies, it is left to the railroad to compute the cost of the stop by multiplying the gallons of fuel wasted for a given weight train making a stop from a given speed on either level tangent track or given grade tangent track, by the cost per gallon.

Results.

It is not feasible to present either a simple formula or the four variables (Train Weight, Speed, Grade, and Fuel Wasted) on a single chart.

The results of the computations are presented in the following tables and charts, A.A.R. Sig. Sec. 7066 through 7071.

Each shows the cost in fuel wasted account of making a stop by various weight trains from various speeds on tangent track for a particular grade.

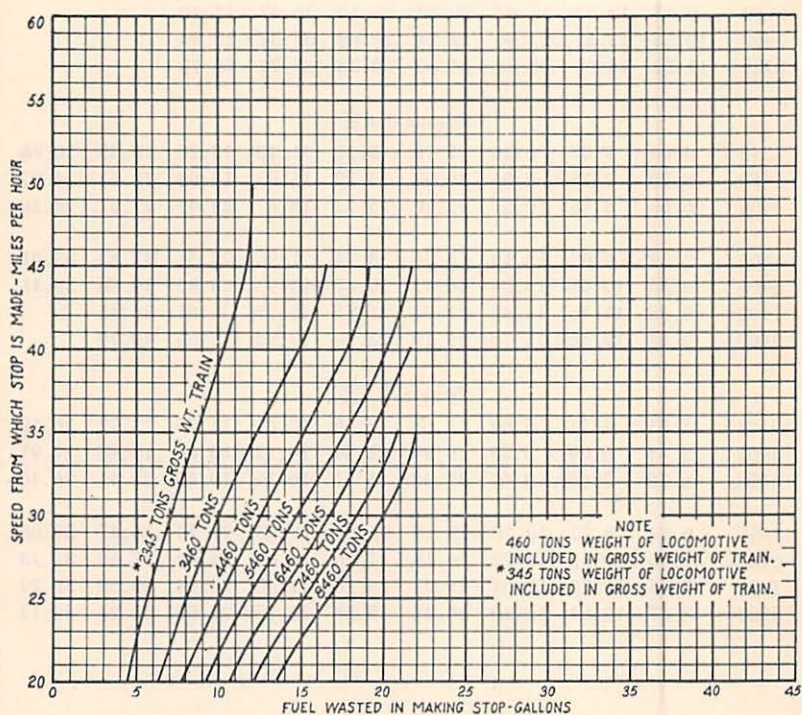
Train weight incl. locomotive in tons	Fuel Wasted in Gallons							
	Speeds from which stop is made in miles per hour							
	20	25	30	35	40	45	50	55 60
	Level							
2345	4.42	5.60	7.05	8.64	10.32	11.73	12.05	
3460	6.30	8.00	10.02	12.29	14.94	16.51		
4460	7.76	10.03	12.58	15.20	17.78	19.12		
5460	9.21	11.77	14.73	17.78	20.20	21.75		
6460	10.67	13.54	16.75	19.25	21.61			
7460	12.13	15.14	18.39	20.82				
8460	13.47	16.62	20.01	21.96				
	Plus 0.2%							
2345	4.45	5.57	6.87	8.24	9.61	10.72		
3460	6.45	8.09	9.92	11.85	13.68	14.82		
4460	8.02	9.92	12.04	13.95	16.39			
5460	9.43	11.59	13.83	16.41				
6460	11.17	13.31	15.56					
7460	12.84	15.01						
8460	14.61	17.36						
	Plus 0.4%							
2345	4.57	5.59	6.74	7.88	9.21			
3460	6.60	8.02	9.60	11.10	13.05			
4460	8.36	9.94	12.30					
5460	10.12	11.71						
6460	11.96							
7460	15.23							
	Plus 0.6%							
2345	4.66	5.52	6.56	8.05				
3460	6.78	8.02	9.33					
4460	7.83	10.01						
5460	11.60							
	Plus 0.8%							
2345	4.80	5.61	7.13					
3460	7.13	8.10						
4460	9.64							
	Minus 0.2%							
2345	4.36	5.52	6.87	8.56	10.44	12.38	13.69	14.53
3460	6.36	8.07	10.02	12.35	14.98	17.56	19.14	
4460	7.73	9.85	12.24	15.29	18.55	21.41	21.96	
5460	9.02	11.58	14.73	18.32	22.08	25.02		
6460	10.44	13.40	17.08	21.20	25.10	27.32		
7460	11.72	15.08	19.27	23.72	27.73	29.43		
8460	13.02	16.86	21.49	26.36	30.48	30.71		

Sept. 1951]

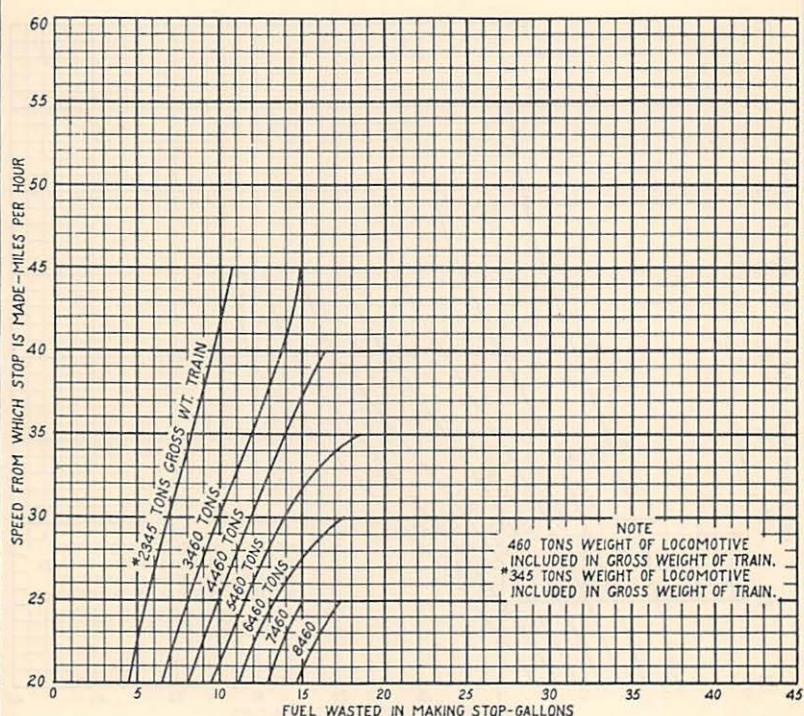
Com. I—Economics of Ry. Signaling

Fuel Wasted in Gallons—Continued

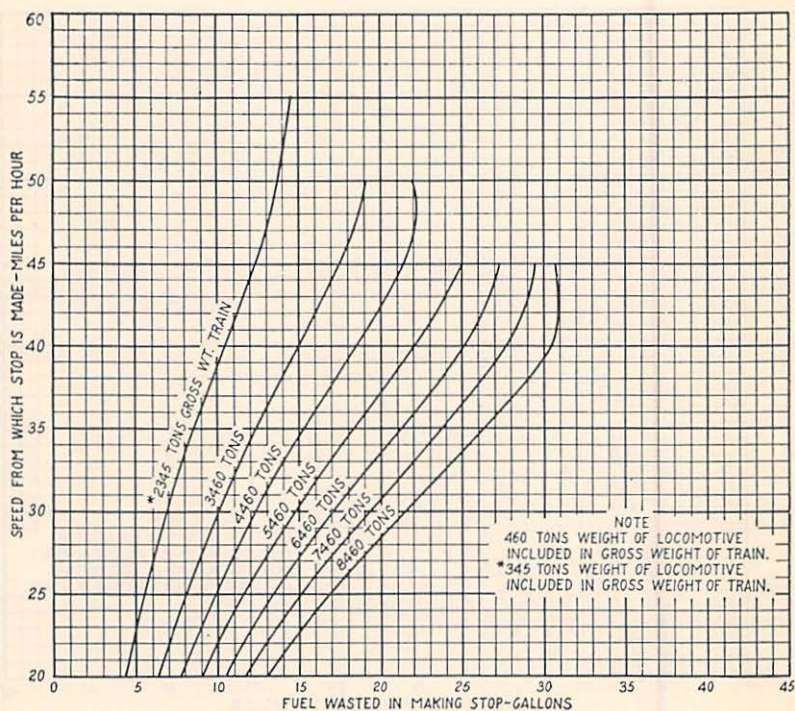
Train weight incl. locomotive in tons	Speeds from which stop is made in miles per hour								
	20	25	30	35	40	45	50	55	60
Minus 0.4%									
2345	4.28	5.50	6.95	8.62	10.61	12.90	14.17	15.67	
3460	6.08	7.76	9.81	12.24	15.07	18.41	20.21	22.09	
4460	7.23	9.27	11.96	14.86	18.51	22.77	24.75	26.15	
5460	8.43	10.94	13.91	17.51	21.76	26.95	29.10	29.42	
6460	9.27	12.22	15.67	20.22	25.10	30.47	32.40		
7460	10.28	13.57	17.46	22.14	27.68	34.37	35.96		
8460	11.32	14.70	18.88	24.30	30.38	37.72	38.76		
Minus 0.6%									
2345	4.04	5.07	6.28	7.70	9.32	11.15	13.28	15.85	16.88
3460	5.70	7.18	8.94	10.98	13.30	15.93	18.99	22.72	24.07
4460	6.60	8.45	10.51	12.96	15.72	18.87	22.47	27.07	28.56
5460	7.52	9.65	12.18	15.04	18.24	21.96	26.31	31.83	33.01
6460	8.36	10.65	13.34	16.47	19.87	23.93	28.80	34.86	35.11
7460	9.08	11.46	14.49	17.94	21.76	26.27	31.61	38.41	
8460	9.87	12.58	15.70	19.19	23.34	27.92	33.66	40.79	
Minus 0.8%									
2345	3.81	4.74	5.84	7.07	8.46	10.01	11.75	13.77	16.19
3460	5.35	6.69	8.23	9.98	11.94	14.12	16.60	19.48	22.91
4460	6.10	7.65	9.47	11.48	13.77	16.39	19.19	22.41	26.40
5460	6.89	8.72	10.78	13.13	15.69	18.53	21.73	25.47	30.06
6460	7.56	9.55	11.72	14.19	17.06	20.04	23.46	27.56	32.78
7460	8.03	10.20	12.61	15.23	18.16	21.46	25.18	29.59	35.29
8460	8.57	10.84	13.39	16.28	19.38	22.78	26.66	31.24	37.12

AAR
SIG. SEC.
7066FUEL OIL WASTED IN STOPPING VARIOUS GROSS WEIGHT TRAINS OF 50-TON CARS
HAULED BY DIESEL-ELECTRIC LOCOMOTIVES ON LEVEL TANGENT TRACK

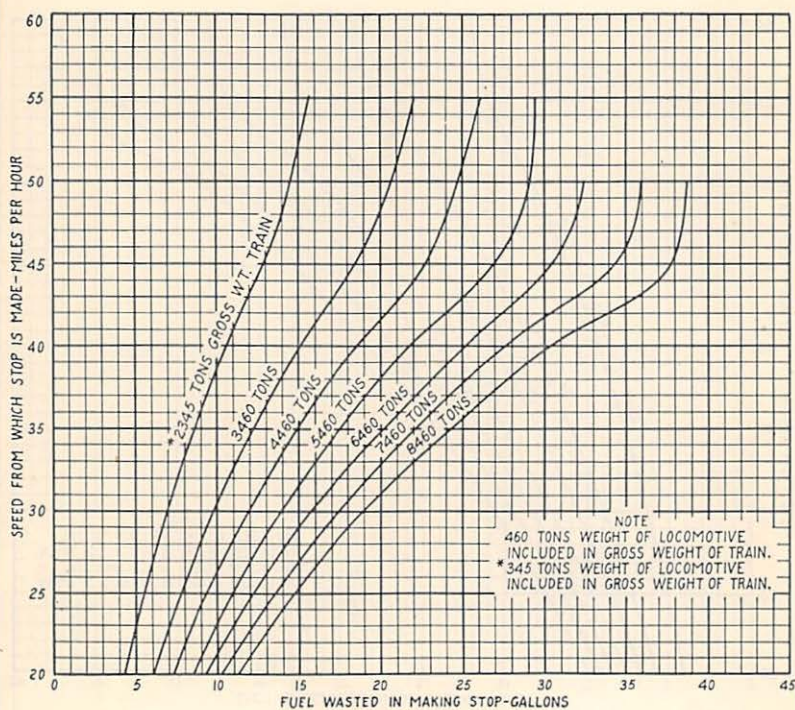
SEP. 1951



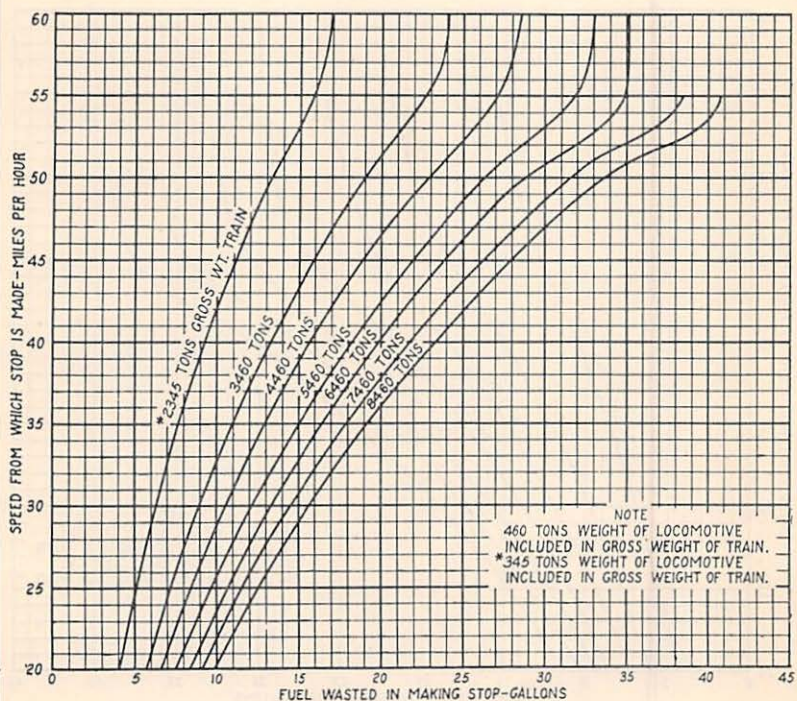
AAR FUEL OIL WASTED IN STOPPING VARIOUS GROSS WEIGHT TRAINS OF 50-TON CARS
 SIG. SEC. HAULED BY DIESEL-ELECTRIC LOCOMOTIVES ON PLUS 0.2% GRADE TANGENT TRACK
 7067 SEP. 1951



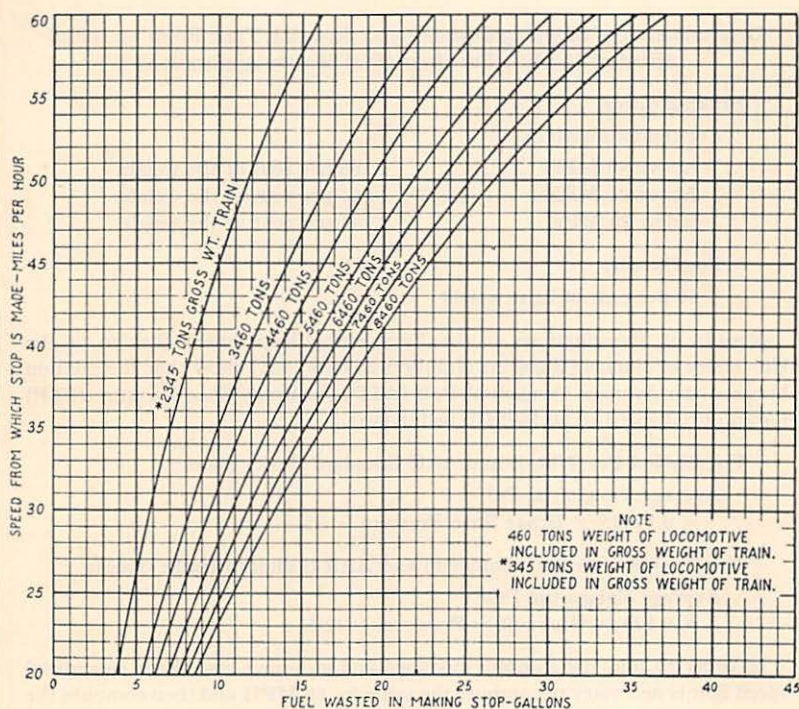
AAR FUEL OIL WASTED IN STOPPING VARIOUS GROSS WEIGHT TRAINS OF 50-TON CARS
 SIG. SEC. HAULED BY DIESEL-ELECTRIC LOCOMOTIVES ON MINUS 0.2 % GRADE TANGENT TRACK
 7068 SEP. 1951



AAR FUEL OIL WASTED IN STOPPING VARIOUS GROSS WEIGHT TRAINS OF 50-TON CARS
 SIG. SEC. HAULED BY DIESEL-ELECTRIC LOCOMOTIVES ON MINUS 0.4 % GRADE TANGENT TRACK
 7069 SEP. 1951

A.A.R.
SIG. SEC.
7070FUEL OIL WASTED IN STOPPING VARIOUS GROSS WEIGHT TRAINS OF 50-TON CARS
HAULED BY DIESEL-ELECTRIC LOCOMOTIVES ON MINUS 0.6 % GRADE TANGENT TRACK

SEP 1951



AAR FUEL OIL WASTED IN STOPPING VARIOUS GROSS WEIGHT TRAINS OF 50-TON CARS
SIG. SEC. HAULED BY DIESEL-ELECTRIC LOCOMOTIVES ON MINUS 0.8% GRADE TANGENT TRACK
7071 SEP. 1951

Typical example.

The following gives the detailed procedure:

General Data

Locomotive.....	Three 1,500 H.P. Diesel-electric units
	Total weight—345 tons
Forty cars.....	Light weight—22 tons each
	Loaded weight—50 tons each
Total weight of train.....	2,345 tons
Speed.....	40 miles per hour
Track.....	Level tangent

Determination of Stopping Distance and Stopping Time From an Initial Speed of 40 Miles Per Hour (Full Service Application)

Braking ratios:

For the locomotive:

Above 40 MPH.....	85 per cent of the weight
Above 20 MPH.....	64 per cent of the weight
Below 20 MPH.....	41 per cent of the weight

For the cars:

60 per cent of light weight

Results of investigations at the Engineering Experiment Station of the University of Illinois (Bulletins Numbers 257 and 301) show that the relation between the Average Tangential Pull (ATP) vs. Brake Shoe Pressure (BSP) for an initial speed of 60 MPH is as follows:

For Chilled Car Wheels and AAR Standard Brake Shoes:

$$\begin{aligned} \text{Average Tangential Pull} \\ = 0.14625 \times \text{Brake Shoe Pressure} - 25 \end{aligned}$$

For Steel Wheels (36" diameter) and AAR Standard Brake Shoes:

$$\begin{aligned} \text{Average Tangential Pull} \\ = 0.125 \times \text{Brake Shoe Pressure} + 12.5 \end{aligned}$$

In order to find the stopping distance and stopping time from any initial speed S , it is necessary to compute the same for 60 MPH and then compute the values for the speed under consideration by means of the relations:

$$SD_S = \left(\frac{S}{60} \right)^2 SD_{60}$$

$$ST_S = \left(\frac{S}{60} \right) ST_{60}$$

where SD = Stopping Distance

ST = Stopping Time

S = Speed under consideration in MPH

Retarding Force for the locomotive (3 Units):

Between 60 and 40 MPH:

Braking Ratio = 85 per cent of the weight

Total Brake Shoe Pressure

$$= 0.85 \times 345 \times 2,000$$

$$= 586,000 \text{ pounds}$$

$$\text{Brake Shoe Pressure per Shoe} = \frac{586,000}{48} = 12,200 \text{ pounds}$$

Average Tangential Pull per Shoe

$$= 0.125 \times 12,200 + 12.5 = 1,537.5 \text{ pounds}$$

Total Average Tangential Pull

$$= 1,537.5 \times 48 = 73,750 \text{ pounds}$$

Between 40 and 20 MPH:

Braking Ratio = 64 per cent of the weight

$$\text{Total BSP} = 0.64 \times 345 \times 2,000 = 441,600 \text{ pounds}$$

$$\text{BSP per Shoe} = \frac{441,600}{48} = 9,200 \text{ pounds}$$

$$\text{ATP per Shoe} = 0.125 \times 9,200 + 12.5 = 1,162.5 \text{ pounds}$$

$$\text{Total ATP} = 1,162.5 \times 48 = 55,700 \text{ pounds}$$

Below 20 MPH:

Braking Ratio = 41 per cent of the weight

$$\text{Total BSP} = 0.41 \times 345 \times 2,000 = 282,900 \text{ pounds}$$

$$\text{BSP per Shoe} = \frac{282,900}{48} = 5,900 \text{ pounds}$$

$$\text{ATP per Shoe} = 0.125 \times 5,900 + 12.5 = 750 \text{ pounds}$$

$$\text{Total ATP} = 750 \times 48 = 36,000 \text{ pounds}$$

Retarding Force for the Cars:

It is obvious that, even though the braking ratio for the cars is fixed, the retarding force does not remain constant. The time element involved in the action of air over the length of the train after a brake application changes the retarding force, *i.e.*, it increases steadily with time. Hence, the length of the train (the number of cars in the train), is an influencing factor.

The retarding forces for the cars are computed for 15 second intervals, during which the force is assumed to be constant, and the Average Brake Cylinder Pressure is as shown in Figs. 1 and 2.

Braking Ratio = 60 per cent of light weight

$$\text{Total Brake Shoe Pressure} = 0.60 \times 22 \times 2,000 = 26,400 \text{ pounds}$$

$$\text{Brake Shoe Pressure per Shoe} = \frac{26,400}{8} = 3,300 \text{ pounds}$$

$$\text{Average Tangential Pull} = 0.14625 \times 3,300 - 25 = 458 \text{ pounds}$$

$$\text{Total Average Tangential Pull per Car} = 458 \times 8 = 3,664 \text{ pounds}$$

$$\text{Total Retarding Force for 40 cars} = 3,664 \times 40 = 146,560 \text{ pounds}$$

(This is true only at Full Brake Cylinder Pressure, *i.e.*, 100 per cent Nominal)

Figure 1 gives the following for a train of 40 cars:

Time period after brake valve movement in seconds	Brake cylinder pressure in per cent of nominal
0—15	22.8
15—30	81.0
30—	99.0

Hence the Total Retarding Force for the cars is

$$146,560 \times 0.228 = 33,400 \text{ pounds during the first 15 seconds}$$

$$146,560 \times 0.81 = 118,700 \text{ pounds during the second 15 seconds}$$

$$146,560 \times 0.99 = 145,000 \text{ pounds thereafter}$$

Using the values of Retarding Forces for the Locomotive and Cars obtained above, the Stopping Distance and Stopping Time from an initial speed of 60 MPH are computed as follows:

During the first 15 seconds after brake valve movement:

$$\text{Total Retarding Force} = 73,750 + 33,400 = 107,150 \text{ pounds}$$

$$\begin{aligned} \text{Average Retardation} &= \frac{\text{Force}}{\text{Mass}} = \frac{\text{Force}}{\frac{\text{Weight}}{g}} = \frac{\text{Force} \times g}{\text{Weight}} \\ &= \frac{107,150 \times 32.2}{2,345 \times 2,000} \\ &= 0.735 \text{ feet per second per second} \end{aligned}$$

$$60 \text{ Miles per Hour} = 88 \text{ feet per second}$$

$$\begin{aligned} \text{Speed at end of 15 second period} &= 88 - (0.735 \times 15) \\ &= 76.95 \text{ feet per second} \\ &= 52.5 \text{ miles per hour} \end{aligned}$$

$$\begin{aligned} \text{Distance Traveled} &= \frac{\text{Change in Kinetic Energy}}{\text{Retarding Force}} \\ &= \frac{70 \times W (S_1^2 - S_2^2)}{\text{Retarding Force}} \end{aligned}$$

Where W = Weight of locomotive and cars in tons

S_1 = Initial speed in MPH

S_2 = Final speed in MPH

$$\text{Distance Traveled} = \frac{70 \times 2,345 (60^2 - 52.5^2)}{107,150} = 1,292 \text{ feet}$$

During the second 15 seconds after brake valve movement:

$$\begin{aligned} \text{Total Retarding Force} &= 73,750 + 118,700 = 192,450 \text{ pounds} \\ &\text{(until speed drops to} \\ &\text{40 MPH)} \end{aligned}$$

$$\begin{aligned} \text{Average Retardation} &= \frac{192,450 \times 32.2}{2,345 \times 2,000} \\ &= 1.311 \text{ feet per second per second} \end{aligned}$$

During this 15 second period, the speed will drop below 40 MPH, and, since the locomotive retarding force changes at 40 MPH, the computations must be made in two steps.

Initial Speed = 52.5 MPH = 76.95 feet per second

Intermediate Speed = 40 MPH = 58.7 feet per second

$$\text{Elapsed Time} = \frac{76.95 - 58.7}{1.311} = 13.9 \text{ seconds}$$

$$\text{Distance Traveled} = \frac{70 \times 2,345 (52.5^2 - 40^2)}{192,450} = 985 \text{ feet}$$

During the remaining 15—13.9 = 1.1 seconds

Total Retarding Force = 55,700 + 118,700 = 174,400 pounds

$$\begin{aligned} \text{Average Retardation} &= \frac{174,400 \times 32.2}{2,345 \times 2,000} \\ &= 1.2 \text{ feet per second per second} \end{aligned}$$

$$\begin{aligned} \text{Speed at end of this 1.1 second period} &= 58.7 - (1.1 \times 1.2) \\ &= 57.38 \text{ feet per second} \\ &= 39.15 \text{ miles per hour} \end{aligned}$$

$$\text{Distance Traveled} = \frac{70 \times 2,345 (40^2 - 39.15^2)}{174,400} = 63.0 \text{ feet}$$

$$\begin{aligned} \text{Total Distance Traveled during second 15 second period} \\ &= 985 + 63 = 1,048 \text{ feet} \end{aligned}$$

During remaining time:

Total Retarding Force = 55,700 + 145,000 = 200,700 pounds
(until speed drops to
20 MPH)

$$\begin{aligned} \text{Average Retardation} &= \frac{200,700 \times 32.2}{2,345 \times 2,000} \\ &= 1.375 \text{ feet per second per second} \end{aligned}$$

Initial Speed = 39.15 MPH = 57.38 feet per second

Intermediate Speed = 20 MPH = 29.35 feet per second

$$\text{Elapsed Time} = \frac{57.38 - 29.35}{1.375} = 19.9 \text{ seconds}$$

$$\text{Distance Traveled} = \frac{70 \times 2,345 (39.15^2 - 20^2)}{200,700} = 935 \text{ feet}$$

Total Retarding Force = 36,000 + 145,000 = 181,000 pounds
(Below 20 MPH)

$$\begin{aligned} \text{Average Retardation} &= \frac{181,000 \times 32.2}{2,345 \times 2,000} \\ &= 1.241 \text{ feet per second per second} \end{aligned}$$

$$\text{Elapsed Time} = \frac{29.35 - 0}{1.241} = 23.6 \text{ seconds}$$

$$\text{Distance Traveled} = \frac{70 \times 2,345 (20^2 - 0^2)}{181,000} = 363 \text{ feet}$$

$$\begin{array}{r} \text{Total Stopping Distance} = 1,292 \\ \text{(from 60 MPH)} \quad 1,048 \\ \quad 935 \\ \quad 363 \\ \hline 3,638 \text{ feet} \end{array}$$

$$\begin{array}{r} \text{Total Stopping Time} = 15 \\ \text{(from 60 MPH)} \quad 15 \\ \quad 19.9 \\ \quad 23.6 \\ \hline 73.5 \text{ seconds} \end{array}$$

Stopping Distance from initial speed of 40 MPH

$$= \left(\frac{40}{60} \right)^2 \times 3,638 = 1,616 \text{ feet}$$

Stopping Time for initial speed of 40 MPH

$$= \frac{40}{60} \times 73.5 = 49 \text{ seconds}$$

To obtain practical values for stopping distances and stopping times, the calculated theoretical values have been increased $33\frac{1}{3}$ per cent

Speed in MPH	Practical stopping distance in feet	Practical stopping time in seconds
60	$3,638 \times 1.333 = 4,850$	$73.5 \times 1.333 = 98$
40	$1,616 \times 1.333 = 2,154$	$49 \times 1.333 = 65$

Determination of Acceleration Time and Distance to Get Train Back to Running Speed

The acceleration distance and acceleration time were computed by the method of increments, the basic data being:

Tractive Force in Pounds vs. Speed in Miles per Hour of a Diesel-electric locomotive unit as shown in Fig. 3

Train Resistance in Pounds per Ton vs. Speed in Miles per Hour for a 50 ton gross weight car, as obtained from the Engineering Experiment Station of the University of Illinois Bulletins Numbers 43 and 376

Grade Resistance in Pounds per Ton, given as 20 pounds per ton per per cent grade

and the fundamental relations:

$$a = \frac{P}{96 W}$$

where a = Acceleration in Miles per Hour per Second

P = Pull in Pounds available to produce acceleration

W = Total Weight of Train (including locomotive) in Tons

An allowance of 5 per cent is included to account for the inertia of the rotating parts (wheels, axles, and motors)

Area under curve $\frac{1}{a}$ (reciprocal of acceleration) in seconds per mile per hour vs.

Speed in miles per hour equals Time in seconds

$$\int \frac{1}{a} dv = \int \frac{1}{\frac{dv}{dt}} dv = \int dt = t$$

Area under curve Speed in miles per hour vs. Time in seconds (adjusted account units of measurement) equals Distance in feet

$$\int v dt = \int \frac{ds}{dt} dt = \int ds = s \text{ (distance)}$$

The following tabulation gives a sample set of computations for a 2,345 Ton Train (345 ton 3-unit locomotive and 40 50-ton loaded freight cars) being accelerated from a standing position up to approximately balancing speed:

1 Speed in MPH	2 Total TF in pounds	3 Train res. in lbs/ton	4 Grade res. in lbs/ton	5 Total train res. in pounds	6 Net pull in pounds	7 Acceler. in $\frac{\text{MPH}}{\text{s}}$	8 $\frac{1}{a}$ in $\frac{\text{s}}{\text{MPH}}$	9 Time in seconds	10 Distance in feet
5	107,250	3.7	0	8,677	98,573	0.4378	2.284	11.4	41.8
10	107,250	4.0	0	9,380	97,870	0.4348	2.300	23.0	168.7
14.5	107,250	4.19	0	9,826	97,424	0.4327	2.311	33.6	357.3
15	103,950	4.2	0	9,849	94,101	0.4181	2.392	35.0	385.0
20	77,220	4.6	0	10,787	66,433	0.2951	3.389	49.6	777.3
25	61,380	5.0	0	11,725	49,655	0.2206	4.534	69.6	1,446.1
30	51,480	5.5	0	12,898	38,582	0.1714	5.835	96.0	2,481.6
35	44,205	6.1	0	14,305	29,900	0.1328	7.529	129.8	4,101.5
40	38,940	6.8	0	15,946	22,994	0.1021	9.790	173.2	6,493.1
45	34,650	7.7	0	18,057	16,593	0.07371	13.567	230.6	10,070.8
50	30,690	9.1	0	21,340	9,350	0.04153	24.077	320.0	16,412.6
55	28,380	10.9	0	25,561	2,819	0.01252	79.858	579.8	36,124.6
60	26,070	13.2	0	30,954					

The foregoing tabulation was made step-by-step as follows:

Col. 1. These values of Speed in miles per hour are in agreement with the assumption that costs would be determined for speed increments of 5 MPH from 20 MPH up, while those below 20 MPH were selected to obtain reasonable accuracy, 14.5 being the break point in the Tractive Force vs. Speed.

Col. 2. These values of Tractive Force in pounds for the complete locomotive were obtained by reading from Fig. 3 the Tractive Force at the Speed in Column 1, multiplying this by the Number of Units in the Locomotive (3 in this case), and multiplying this by 1.1 (because the locomotive is capable of exerting 10 per cent more tractive force than shown on Fig. 3).

Col. 3. These values of Train Resistance in pounds per ton were obtained for the speed in Column 1 from the Engineering Experiment Station of the University of Illinois Bulletins Numbers 43 and 376.

- Col. 4. The values of Grade Resistance in pounds per ton would be obtained by multiplying 20 pounds per ton per per cent grade by the grade in per cent; for example, for the stops on a plus 0.2 per cent grade, the grade resistance in pounds per ton would be plus 4.0 for all speeds in Column 1; while for the stops on a minus 0.2 per cent grade, the grade resistance in pounds per ton would be minus 4.0 for all speeds in Column 1.

In this sample set of computations, the grade resistance in pounds per ton is 0 for all speeds in Column 1, because the track is level.

- Col. 5. The values of Total Train Resistance in pounds were obtained by multiplying the sum of Columns 3 and 4 by the total weight of the train in tons (in this case 2,345).

The weight of the locomotive is included in the total weight of the train, because the tractive force of the locomotive unit is at the driver axle.

- Col. 6. The values of Net Pull in pounds were obtained by subtracting Column 5 from Column 2.

- Col. 7. The values of Acceleration (a) in $\frac{\text{MPH}}{\text{s}}$ were obtained by dividing Column 6 by $96 \times$ the total weight of the train in tons (in this case, $96 \times 2,345 = 225,120$).

- Col. 8. The values of $\frac{1}{a}$ (reciprocal of acceleration) in seconds per mile per hour were obtained by dividing Column 1 by Column 7.

- Col. 9. The values of Time in seconds were obtained by multiplying the area under the curve $\frac{1}{a}$ vs. Speed in Fig. 4 between 0 MPH and the speed in Column 1 by the value of time in seconds per square inch.

In the original work charts, one square inch equalled 20 seconds (2 seconds per mile per hour $\times$ 10 miles per hour).

In this work, the area was obtained by means of a planimeter; however, the approximate area may be obtained either by counting squares or by the method of trapezoids.

- Col. 10. The values of Distance in feet were obtained by multiplying the area under the curve Time vs. Speed in Fig. 5 between 0 Seconds and the seconds in Column 9 by the value of distance per square inch.

In the original work charts, one square inch equalled 586.667 feet (10 miles per hour $\times$ 40 seconds $\times$ 1.466 feet per second per mile per hour).

In this work, the area was obtained by means of a planimeter; however, the approximate area may be obtained either by counting squares or by the method of trapezoids.

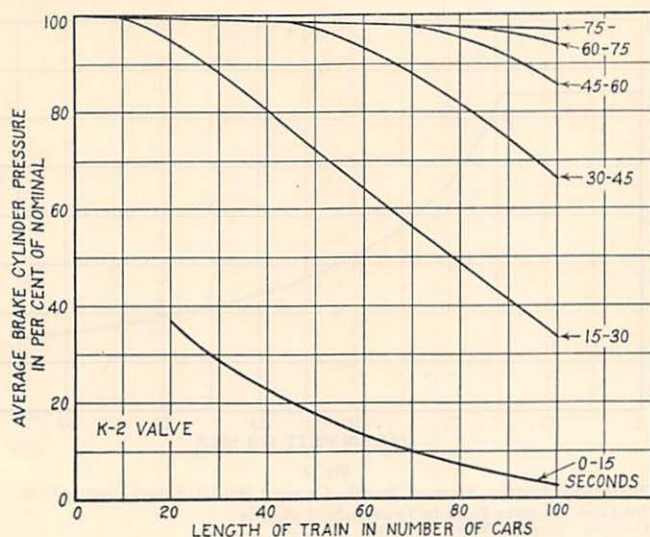


Fig. 1.

Average Brake Cylinder Pressure vs. Length of Train—for different time periods after brake valve movement.

(Purdue University Tests)

Ordinate—Average Brake Cylinder Pressure in Per Cent of Nominal
Abscissa—Length of Train in Number of Cars

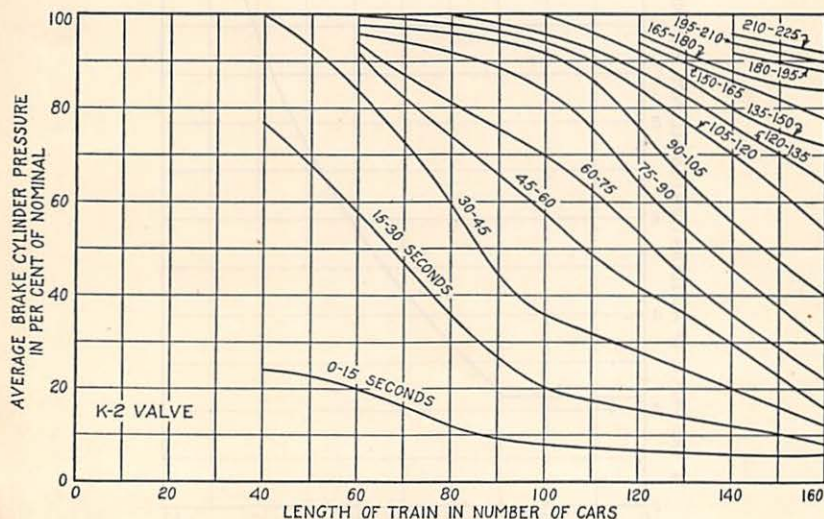


Fig. 2.

Average Brake Cylinder Pressure vs. Length of Train—for different time periods after brake valve movement.

Ordinate—Average Brake Cylinder Pressure in Per Cent of Nominal
Abscissa—Length of Train in Number of Cars

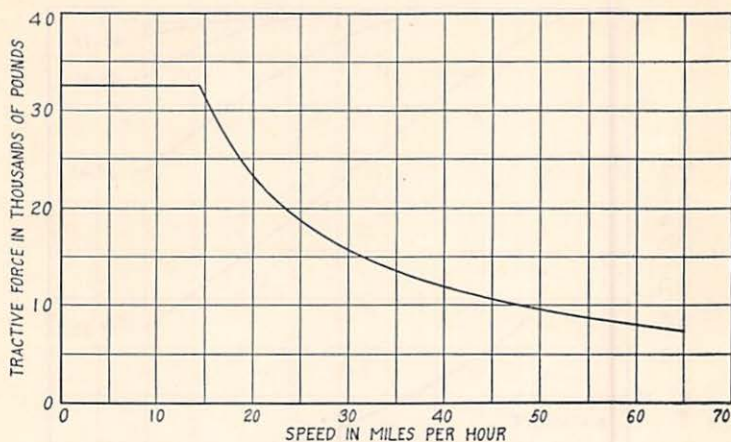


Fig. 3.

Driver Axle Tractive Force vs. Speed—for one 1,500 HP Diesel-Electric Unit.

Ordinate—Tractive Force in Thousands of Pounds

Abscissa—Speed in Miles per Hour

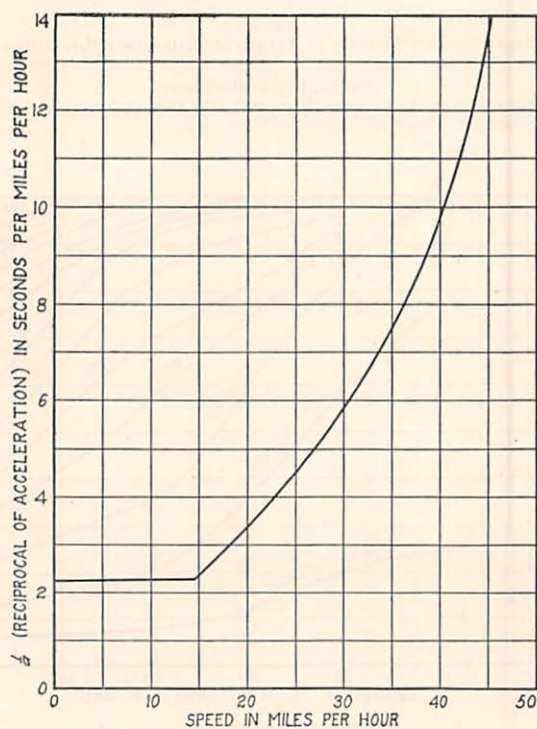


Fig. 4.

 $\frac{1}{a}$ (Reciprocal of Acceleration) vs. Speed.Ordinate — $\frac{1}{a}$ (Reciprocal of Acceleration) in Seconds per Mile per Hour.

Abscissa—Speed in Miles per Hour.

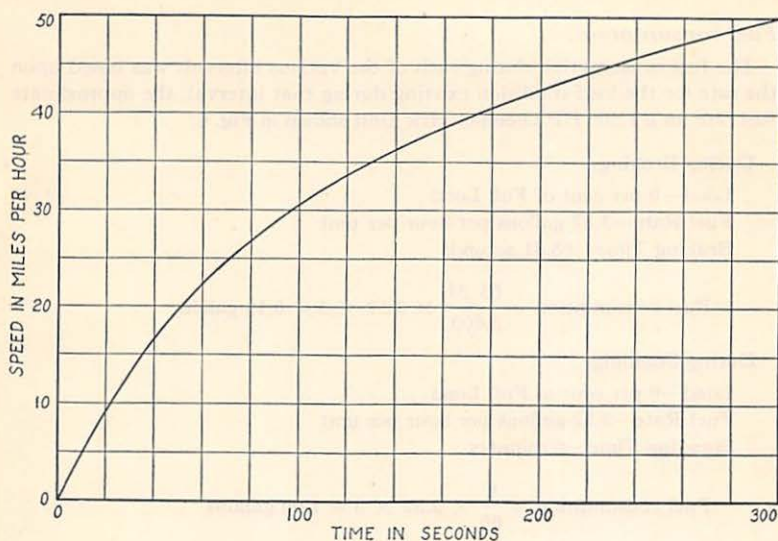


Fig. 5.

Speed vs. Time.

Ordinate—Speed in Miles per Hour.
Abcissa—Time in Seconds.

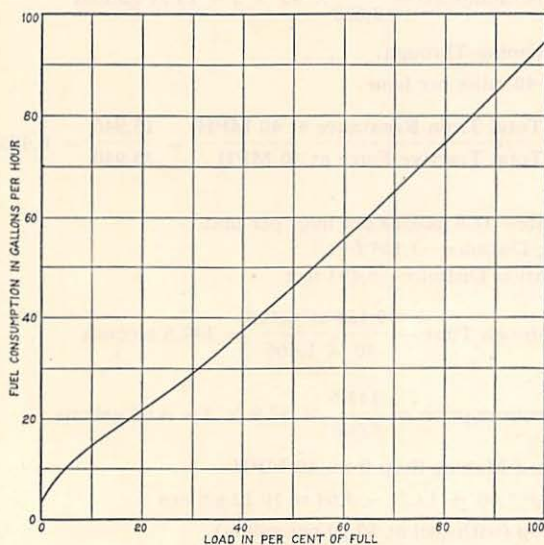


Fig. 6.

Fuel Consumption vs. Load—for a 1,500 HP Diesel-Electric Unit.

Ordinate—Fuel Consumption in Gallons per Hour
Abcissa—Load in Per Cent of Full

Fuel consumption.

The fuel consumption during each of the various intervals was based upon the rate for the load condition existing during that interval, the approximate fuel rate for a 1,500 HP Diesel-electric Unit shown in Fig. 6.

During Braking:

Load—0 per cent of Full Load
Fuel Rate—3.52 gallons per hour per unit
Braking Time—65.31 seconds

$$\text{Fuel consumption} = \frac{65.31}{3,600} \times 3.52 \times 3 = 0.19 \text{ gallon}$$

During Standing:

Load—0 per cent of Full Load
Fuel Rate—3.52 gallons per hour per unit
Standing Time—6 minutes

$$\text{Fuel consumption} = \frac{6}{60} \times 3.52 \times 3 = 1.06 \text{ gallons}$$

During Acceleration:

Load—100 per cent of Full Load
Fuel Rate—95 gallons per hour per unit
Acceleration Time—173.2 seconds

$$\text{Fuel consumption} = \frac{173.2}{3,600} \times 95 \times 3 = 13.71 \text{ gallons}$$

During Running Through:

Speed—40 miles per hour

$$\text{Load} = \frac{\text{Total Train Resistance at 40 MPH}}{\text{Total Tractive Force at 40 MPH}} = \frac{15,946}{38,940} = 0.4095 = 40.95 \text{ per cent of Full Load}$$

Fuel Rate—37.8 gallons per hour per unit
Braking Distance—2,154 feet
Acceleration Distance—6,493 feet

$$\text{Run Through Time} = \frac{2,154 + 6,493}{40 \times 1.466} = 147.6 \text{ seconds}$$

$$\text{Fuel consumption} = \frac{147.6}{3,600} \times 37.8 \times 3 = 4.64 \text{ gallons}$$

Fuel Wasted Making Stop from 40 MPH

$$= 0.19 + 1.06 + 13.71 - 4.64 = 10.32 \text{ gallons}$$

Cost of Stop (with fuel at \$0.10 per gallon)

$$= 10.32 \times 0.10 = \$1.03$$

Action Recommended
Acceptance as information,

ECONOMICS OF "OFF TRACK" EQUIPMENT*

During World War II, the Chicago, Milwaukee, St. Paul & Pacific R.R. began furnishing highway vehicles for its signal department construction, maintenance and supervisory forces. The practice has subsequently been expanded and at the present time there are some 70 automobiles and trucks in use by signal maintainers, crews, inspectors and supervisors.

Data on the location and operating costs of units assigned to traveling maintainers having scattered territories are as follows:

Location	Type of vehicle	Miles assigned territory (single track)	Annual cost of operation (1950)**	Average monthly mileage	Average cost per mile
Austin, Minn.	Pick-up truck	444.0	\$1,478	2,203	\$0.056
Beloit, Wis.	Sedan	178.1	663	1,122	0.049
Burlington, Wis.	Sedan	52.6	743	1,074	0.058
Davenport, Iowa	Panel truck	103.2	514	902	0.047
Farmington, Minn.	Sedan	117.9	727	1,233	0.049
Green Bay, Wis.	Sedan	86.7	1,101	1,333	0.069
Horicon, Wis.	Sedan	228.2	916	1,941	0.039
Iron Mountain, Mich.	Panel truck	277.3	771	1,055	0.061
Janesville, Wis.	Pick-up truck	146.1	745	1,483	0.042
Madison, Wis.	Sedan	183.4	1,180	1,340	0.073
Marquette, Iowa	Sedan	236.1	988	1,895	0.043
Mason City, Iowa	Panel truck	185.3	461	993	0.039
Mitchell, S. Dak.	Panel truck	568.0	1,143	1,666	0.057
Ottumwa, Iowa	Sedan	172.0	994	1,487	0.056
Sioux City, Iowa	Sedan	236.2	1,504	2,636	0.048
Spencer, Iowa	Sedan	192.0	1,058	1,224	0.072
Spokane, Wash.	Panel truck	386.6	615	1,659	0.031
Tacoma, Wash.	Panel truck	339.4	792	1,562	0.042
	Average	229.6	\$910	1,489	\$0.051

Vehicles assigned maintainers at terminal and centralized traffic control points have not been included as the service in which they are used would not be typical. The following summaries of the maintenance territories are representative:

* Previous report on this subject appears in A.A.R. Signal Section 1943 Proceedings, Vol. XLI, pp. 16 and 282.

** Includes gas, oil, licenses, garage rent, repairs, replacements, depreciation and insurance.

Beloit, Wis.

Thirty-five highway crossing signal installations, 4.4 miles C.T.C. and A.B.S. One automatic interlocking, 1 remote control interlocking, 3 spring switches and signals, 10 train order signals.

Burlington, Wis.

Thirty highway crossing signal installations, 10 mechanical train order signals, 1 mechanical interlocking, 1 automatic interlocking.

Horicon, Wis.

Sixty highway crossing signal installations, 14 train order signals, 1 railroad crossing gate, 1 mechanical interlocking.

Mason City, Iowa

Twenty-five highway crossing signal installations, 4 automatic interlockings, 3 switch protection signals, 20 train order signals.

Ottumwa, Iowa

Twenty-eight highway crossing signal installations, 2 mechanical interlockings, 1 automatic interlocking, 1 remote control interlocking, 4 miles C.T.C., 10 spring switches and signals, 6 train order signals.

Spencer, Iowa

Twenty highway crossing signal installations, 5 automatic interlockings, 2 spring switches and signals, 9 train order signals.

Summary of Advantages

1. Reduction in traveling and waiting time, overtime and personal expenses.
2. Elimination of necessity for securing train line-ups with attendant delays and complications.
3. Reduction in mileage due to ability to make cross country trips and to follow more direct routes.
4. Ability to reach points having limited or no passenger train service.
5. Greater capacity for carrying tools, supplies, material and men.
6. Faster coverage of territory, permitting more time for inspection and maintenance.
7. Greater mobility in case of storms, accidents or other trouble.
8. Ability to cover adjoining maintainer's territories in case of emergency.
9. Operation under adverse weather conditions.
10. Partially offsets time lost due to establishment of 40-hour week.

Action Recommended

Acceptance as information.

ECONOMICS OF AUTOMATIC, AUTO-MANUAL AND MANUAL-CONTROLLED HIGHWAY CROSSING PROTECTION DEVICES*

Chicago & North Western Ry.

During 1950, the Chicago & North Western Ry. completed improvements in protection for 19 street crossings in Sheboygan, Wis., 15 on the single-track Milwaukee-Green Bay main line and 4 on the single-track Sheboygan-Fond du Lac freight line.

Automatic flashing light signals with rotating stop signs and bells were installed at 12 crossings on the Green Bay line, replacing manually controlled gates at 9 crossings, wig-wags at one crossing, and providing new protection at 2 crossings. Where formerly 20 gatemen were employed, the present installation requires but 10 gatemen, resulting in a saving of 80 man hours daily.

Two manual gate locations on each line were improved by addition of electric gate lights controlled by mercury contacts on the gates. Manual supervision of two existing wig-wag locations was replaced by automatic cut-outs effected by position of hand-throw track switches. Circuiting at another wig-wag location was improved.

A control tower with diagrammatic panel was provided for auto-manual control of two of the new automatic signal installations. At present, the tower is attended 16 hours daily. Automatic cut-outs have been provided for the other new installations where varying speed and switching conditions indicated their need.

Center track circuits on all tracks were provided at each crossing protected by either new or old automatic devices, and extra shunting sensitivity was obtained by providing primary-secondary relays for these circuits.

Attendance at existing manual gate locations on the Green Bay line is now continuous. The installation includes "No Right Turn" and "No Left Turn" signs and "flashing yellow" signals operating in conjunction with the flashing light signals with rotating stop signs.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$102,700
(b) Operating Expenses.....	8,765
(c) Total.....	\$111,465
2. Annual Operating Expenses before Installation.....	\$ 78,339
3. Annual Operating Expenses after Installation.....	41,707
4. Net Reduction in Annual Operating Expenses.....	\$ 36,632
5. Deduction for Interest and Depreciation Charges @ 6.5% (of 1-a).....	6,676
6. Net Saving per Annum.....	\$ 29,956
7. Annual Return over 6.5% Interest and Depreciation:	
(a) On Capital Investment (6 ÷ 1-a).....	29.2%
(b) On Total Cost (6 ÷ 1-c).....	26.9%

* Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 20 and 318.

Chicago, Milwaukee, St. Paul & Pacific R.R.

During 1950 the Chicago, Milwaukee, St. Paul & Pacific R.R. provided modern, automatic crossing protection at several stations on its Eastern Lines in place of older forms of protection. The locations of the installations, cost and savings data are as follows:

Location	No. of crossings protected	Cost of new protection	Net reduction in operating expenses	Annual return, per cent
Milwaukee, Wis. †.....	4	\$33,036	\$16,603	50.3
Rondout, Ill.	1	17,800	12,230	68.7
Elm Grove, Wis.	1	9,885	6,135	62.1
Rockford, Ill.	5	7,582	6,188	81.6
Mason City, Iowa.....	1	5,433	3,539	65.1
Cedar Rapids, Iowa....	1	4,721	7,310	154.8
Boscobel, Wis.	1	6,284	2,926	46.6
Glencoe, Minn.	1	6,070	2,844	46.8
Brodhead, Wis.	3	10,794	3,396	31.5

† Automatic control added for existing signals.

Consolidated Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$95,025
(b) Operating Expenses.....	6,580
(c) Total.....	<u>\$101,605</u>
2. Annual Operating Expenses before Installation.....	\$ 66,671
3. Annual Operating Expenses after Installation.....	<u>5,500</u>
4. Net Reduction in Annual Operating Expenses.....	\$ 61,171
5. Deduction for Interest and Depreciation Charges @ 6.5% (of 1-a).....	<u>6,177</u>
6. Net Saving per Annum.....	<u>\$ 54,994</u>
7. Annual Return over 6.5% Interest and Depreciation:	
(a) On Capital Investment (6 ÷ 1-a).....	57.9%
(b) On Total Cost (6 ÷ 1-c).....	54.1%

Summary of Advantages

1. Dependable 24-hour automatic operation.
2. Uniform and more effective type of protection.
3. Increased safety for both street traffic and train operation.
4. Reduction of \$61,171 in operating expenses.

Action Recommended

Acceptance as information.

**FORMULA FOR ESTIMATING TRAIN MILES SAVED
DUE TO INCREASED TONNAGE WITH
CENTRALIZED TRAFFIC CONTROL**

At the 1950 Annual Meeting* the Committee presented a report on this subject which included a table showing road freight train crews' wages and specified elements of freight service cost per ordinary train mile for the calendar year 1948. The same data for the calendar year 1949 are shown in following Table I:

TABLE I

**Road Freight Train Crews' Wages and Specified Elements of Freight Service
Cost per Ordinary Train Mile—Calendar Year 1949**

Railroad	Road freight train crews' wages a	Fuel, supplies, enginehouse expense and locomotive repairs b	Payroll taxes on crew wages and labor applicable to locomotive repairs and shop and enginehouse expense c	Total
NEW ENGLAND REGION:				
1 Bangor & Aroostook.....	97.08¢	149.25¢	8.04¢	254.37¢
2 Boston & Maine.....	102.71	145.03	9.13	256.87
3 Central Vermont.....	95.11	194.81	9.20	299.12
4 Maine Central.....	92.24	149.07	8.51	249.82
5 New York, New Haven & Hartford.....	109.99	210.63	10.93	331.55
6 Rutland.....	83.61	210.87	8.71	303.19
GREAT LAKES REGION:				
7 Grand Trunk Western.....	80.84	155.13	7.08	243.05
8 Erie (Incl. Chgo. & Erie).....	108.42	199.61	10.72	318.75
9 New York, Chgo. & St. Louis (Incl. W. & L. E.).....	91.40	204.83	8.90	305.13
10 Delaware & Hudson.....	107.42	315.56	13.47	436.45
11 Delaware, Lackawanna & Western.....	116.30	203.87	10.47	330.64
12 Lehigh & New England.....	164.93	130.78	11.97	307.68
13 Lehigh Valley.....	132.72	204.14	11.23	348.09
14 Monongahela.....	144.82	217.76	13.07	375.65
15 New York, Ontario & Western.....	92.86	109.55	8.22	210.63
16 New York Central (Incl. B. & A.).....	100.26	192.11	9.75	302.12
17 Pittsburgh & Lake Erie.....	121.24	329.41	12.58	463.23
18 Ann Arbor.....	74.15	137.29	7.05	218.49
19 Wabash.....	77.02	153.72	7.24	237.98
CENTRAL EASTERN REGION:				
20 Baltimore & Ohio.....	119.70	244.46	12.48	376.64
21 Bessemer & Lake Erie.....	131.69	690.63	27.88	850.20
22 Chicago & Eastern Illinois.....	83.31	138.19	7.26	228.76
23 Chicago, Indianapolis & Louisville.....	82.72	138.93	7.82	229.47
24 Detroit, Toledo & Ironton.....	91.02	178.00	8.28	277.30
25 Elgin, Joliet & Eastern.....	201.05	173.61	15.43	390.09
26 Illinois Terminal.....	84.72	92.23	6.72	183.67
27 Long Island.....	277.46	263.75	21.26	562.47
28 Pennsylvania.....	133.19	235.89	12.57	381.65
29 Cent.R.R.of New Jersey (Incl. C.R.R. of Pa.).....	158.57	284.40	14.58	457.55
30 Reading.....	123.43	238.05	12.19	373.67
31 Western Maryland.....	117.42	338.97	14.92	471.31

a Includes freight proportion of charges to operating expense accounts 392, 393 and 401.

b Includes freight proportion of charges to operating expense accounts 308, 311, 394 to 400, inclusive, and 402.

c Payroll taxes calculated at rate of 6 per cent. Reduction from actual rate of 6.50 per cent account compensation in excess of \$300 per month.

Note.—The figures in this table are expressed in cents per train-mile with decimal fractions of hundredths of one cent, thus: 149.25¢ equals \$1.4925; 97.08¢ equals \$0.9708; 8.04¢ equals \$0.0804, etc.

*A. A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 39 and 319.

TABLE I—Continued

Railroad	Road freight train crews' wages a	Fuel, supplies, enginehouse expense and locomotive repairs b	Payroll taxes on crew wages and labor applicable to locomotive repairs and shop and enginehouse expense c	Total
POCAHONTAS REGION:				
32 Chesapeake & Ohio (Incl. Pere M.).....	95.56¢	218.74¢	10.11¢	324.41¢
33 Norfolk & Western.....	95.45	277.18	10.90	383.53
34 Richmond, Fred'burg & Potomac.....	81.44	227.18	9.12	317.74
35 Virginian.....	114.24	292.24	13.49	419.97
SOUTHERN REGION:				
36 Atlantic Coast Line.....	84.42	152.48	7.62	244.52
37 Clinchfield.....	106.79	240.54	11.55	358.88
38 Louisville & Nashville.....	87.94	164.45	8.72	261.11
39 Nashville, Chattanooga & St. Louis.....	92.35	112.10	7.41	211.86
40 Florida East Coast.....	82.04	140.56	7.31	229.91
41 Gulf, Mobile & Ohio (Incl. Alton).....	81.37	155.41	8.38	245.16
42 Central of Georgia.....	73.58	146.32	7.01	226.91
43 Illinois Central (Incl. Y. & M. V.).....	83.60	151.53	7.69	242.72
44 Norfolk Southern.....	93.45	114.48	8.35	216.28
45 Seaboard Air Line.....	95.53	172.07	9.06	276.66
46 Alabama Great Southern.....	75.08	173.72	8.26	257.06
47 Cincinnati, New Orleans & Tex. Pac.....	78.22	162.11	8.24	248.57
48 Southern.....	82.15	159.35	8.42	249.92
NORTHWESTERN REGION:				
49 Mpls., St. P. & S.S. Marie (Incl. Wis. C.)....	97.78	148.45	8.45	254.68
50 Chicago & North Western.....	98.29	163.68	8.70	270.67
51 Chicago, St. Paul, Mpls. & Omaha.....	94.51	178.14	8.09	280.74
52 Chicago Great Western.....	91.71	111.10	6.96	209.77
53 Chicago, Milwaukee, St. Paul & Pac.....	97.07	166.71	8.72	272.50
54 Duluth, Missabe & Iron Range.....	133.54	381.91	15.93	531.38
55 Great Northern.....	107.19	194.30	10.09	311.58
56 Minneapolis & St. Louis.....	87.75	114.36	7.74	209.85
57 Northern Pacific.....	108.47	179.13	10.03	297.63
58 Spokane, Portland & Seattle.....	127.09	172.30	10.54	309.93
CENTRAL WESTERN REGION:				
59 Atchison, Topeka & Santa Fe.....	86.93	160.90	8.40	256.23
60 Chicago, Burlington & Quincy.....	87.44	124.18	7.01	218.63
61 Colorado & Southern.....	91.23	166.46	8.55	266.24
62 Fort Worth & Denver City.....	86.93	124.66	7.21	218.80
63 Denver & Rio Grande W. (Incl. D. & S. L.)..	113.60	240.15	11.65	365.40
64 Rock Island System.....	89.68	124.17	7.60	221.45
65 Northwestern Pacific.....	145.42	158.43	11.66	315.51
66 Southern Pacific.....	130.41	257.51	13.42	401.34
67 Union Pacific.....	107.25	197.40	9.86	314.51
68 Western Pacific.....	105.43	189.22	10.12	304.77

a Includes freight proportion of charges to operating expense accounts 392, 393 and 401.

b Includes freight proportion of charges to operating expense accounts 308, 311, 394 to 400, inclusive, and 402.

c Payroll taxes calculated at rate of 6 per cent. Reduction from actual rate of 6.50 per cent account compensation in excess of \$300 per month.

Note.—The figures in this table are expressed in cents per train-mile with decimal fractions of hundredths of one cent, thus: 149.25¢ equals \$1.4925; 97.08¢ equals \$0.9708; 8.04¢ equals \$0.0804, etc.

TABLE 1—Continued

Railroad	Road freight train crews' wages ^a	Fuel, supplies, enginehouse expense and locomotive repairs ^b	Payroll taxes on crew wages and labor applicable to locomotive repairs and shop and enginehouse expense ^c	Total
SOUTHWESTERN REGION:				
69 Frisco Lines.....	83.76¢	144.69¢	7.26¢	235.71¢
70 Kansas City Southern.....	86.50	173.94	8.35	268.79
71 Louisiana & Arkansas.....	82.24	164.59	7.81	254.64
72 Missouri-Kansas-Texas.....	81.18	115.50	6.87	203.55
73 Gulf Coast Lines.....	91.73	130.89	7.70	230.32
74 International-Great Northern.....	87.20	128.69	7.62	223.51
75 Missouri Pacific.....	92.12	130.73	7.97	230.82
76 Texas & Pacific.....	86.64	176.21	8.00	270.85
77 St. Louis Southwestern.....	93.17	135.50	7.80	236.47
78 Texas & New Orleans.....	83.75	150.06	8.06	241.87
Composite Average.....	100.62	185.58	9.60	295.80
AVERAGES BY REGIONS:				
New England.....	101.91	174.46	9.56	285.93
Great Lakes.....	99.64	195.24	9.65	304.53
Central Eastern.....	127.45	239.93	12.54	379.92
Poconos.....	96.03	240.58	10.50	347.11
Southern.....	85.32	157.59	8.22	251.13
Northwestern.....	102.05	173.53	9.25	284.83
Central Western.....	102.47	183.33	9.66	295.46
Southwestern.....	87.13	141.15	7.73	236.01

^a Includes freight proportion of charges to operating expense accounts 392, 393 and 401.^b Includes freight proportion of charges to operating expense accounts 308, 311, 394 to 400, inclusive, and 402.^c Payroll taxes calculated at rate of 6 per cent. Reduction from actual rate of 6.50 per cent account compensation in excess of \$300 per month.

Note.—The figures in this table are expressed in cents per train-mile with decimal fractions of hundredths of one cent, thus: 149.25¢ equals \$1.4925; 97.08¢ equals \$0.9708; 8.04¢ equals \$0.0804, etc.

Action Recommended
Acceptance as information.

EFFECT OF VARIOUS CLASSES OF TRACK ON TAXATION †

The State and Local taxes per mile of track operated in 1949 vary from a minimum of \$223 to a maximum of \$4,205, with a composite average for 78 railroads, of \$830. This information has been developed through cooperation with the Bureau of Railway Economics, A.A.R. and is shown in following Table I:

TABLE I
State and Local Taxes per Mile of Track Operated
Calendar Year 1949

Railroad	Average miles of all track operated at close of year	State and local taxes*	
		Total	Per mile of track operated
NEW ENGLAND REGION:			
1 Bangor & Aroostook.....	872.07	\$800,332	\$918
2 Boston & Maine.....	3,277.92	2,824,103	862
3 Central Vermont.....	615.13	160,856	261
4 Maine Central.....	1,328.19	884,905	666
5 New York, New Haven & Hartford.....	4,314.10	4,860,754	1,127
6 Rutland.....	523.29	134,518	257
GREAT LAKES REGION:			
7 Grand Trunk Western.....	2,154.12	1,406,567	653
8 Erie (Incl. Chgo. & Erie).....	5,678.35	5,500,326	969
9 New York, Chgo. & St. Louis (Incl. W. & L.E.).....	3,971.78	3,437,704	866
10 Delaware & Hudson.....	1,737.14	1,478,419	851
11 Delaware, Lackawanna & Western.....	2,417.01	4,216,970	1,745
12 Lehigh & New England.....	323.44	197,146	610
13 Lehigh Valley.....	2,985.67	2,767,764	927
14 Monongahela.....	276.81	186,231	673
15 New York, Ontario & Western.....	835.33	186,275	223
16 New York Central (Incl. B. & A.).....	24,134.56	26,190,524	1,085
17 Pittsburgh & Lake Erie.....	1,059.23	1,106,205	1,044
18 Ann Arbor.....	418.71	222,173	531
19 Wabash.....	4,318.99	2,106,281	488
CENTRAL EASTERN REGION:			
20 Baltimore & Ohio.....	12,087.34	8,958,408	741
21 Bessemer & Lake Erie.....	576.11	414,793	720
22 Chicago & Eastern Illinois.....	1,609.71	767,110	477
23 Chicago, Indianapolis & Louisville.....	819.90	401,873	490
24 Detroit, Toledo & Ironton.....	686.22	530,418	773
25 Elgin, Joliet & Eastern.....	1,084.68	997,063	919
26 Illinois Terminal.....	662.97	389,422	587
27 Long Island.....	913.60	3,841,047	4,205
28 Pennsylvania.....	25,099.56	27,454,329	1,094
29 Cent.R.R. of New Jersey (Incl. C.R.R. of Pa.).....	1,754.17	3,437,224	1,959
30 Reading.....	3,334.94	2,433,665	730
31 Western Maryland.....	1,401.50	1,258,164	898
POCAHONTAS REGION:			
32 Chesapeake & Ohio (Incl. Pere M.).....	9,843.26	11,386,146	1,157
33 Norfolk & Western.....	4,736.20	7,399,181	1,562
34 Richmond, Fred'burg & Potomac.....	485.49	833,833	1,718
35 Virginian.....	1,117.01	1,943,926	1,740
SOUTHERN REGION:			
36 Atlantic Coast Line.....	7,907.65	4,406,164	557
37 Clinchfield.....	480.82	949,422	1,975
38 Louisville & Nashville.....	7,958.62	7,470,931	939
39 Nashville, Chattanooga & St. Louis.....	1,712.75	1,040,893	608
40 Florida East Coast.....	1,225.50	955,482	780
41 Gulf, Mobile & Ohio (Incl. Alton).....	4,331.85	2,513,966	580
42 Central of Georgia.....	2,693.52	1,329,062	493
43 Illinois Central (Incl. Y. & M. V.).....	11,192.27	11,217,750	1,002
44 Norfolk Southern.....	870.02	282,256	324
45 Seaboard Air Line.....	5,848.77	3,569,594	610
46 Alabama Great Southern.....	681.46	663,077	973
47 Cincinnati, New Orleans & Tex. Pac.....	879.55	1,627,186	1,850
48 Southern.....	10,254.02	8,008,761	781

* Represents total tax accruals other than United States Government taxes.

† Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 42 and 320.

TABLE I—Continued

Railroad	Average miles of all track operated at close of year	State and local taxes*	
		Total	Per mile of track operated
NORTHWESTERN REGION:			
49 Mpls., St. P. & S. S. Marie (Incl. Wis. C.).....	5,455.85	\$2,243,019	\$411
50 Chicago & North Western.....	12,286.58	6,313,880	514
51 Chicago, St. Paul, Mpls. & Omaha.....	2,420.35	1,138,853	471
52 Chicago Great Western.....	2,190.06	1,030,642	471
53 Chicago, Milwaukee, St. Paul & Pac.....	15,971.21	9,223,070	577
54 Duluth, Missabe & Iron Range.....	1,197.84	1,965,849	1,641
55 Great Northern.....	12,184.79	11,323,096	929
56 Minneapolis & St. Louis.....	1,780.75	539,631	303
57 Northern Pacific.....	10,623.64	8,302,873	782
58 Spokane, Portland & Seattle.....	1,279.72	1,329,081	1,039
CENTRAL WESTERN REGION:			
59 Atchison, Topeka & Santa Fe.....	21,387.99	16,879,287	789
60 Chicago, Burlington & Quincy.....	13,701.92	9,492,556	693
61 Colorado & Southern.....	1,200.17	605,285	504
62 Fort Worth & Denver City.....	1,176.85	355,027	302
63 Denver & Rio Grande W. (Incl. D. & S. L.)....	3,859.76	2,916,472	756
64 Rock Island System.....	11,280.67	6,199,433	550
65 Northwestern Pacific.....	465.77	200,702	431
66 Southern Pacific.....	13,323.90	16,227,237	1,218
67 Union Pacific.....	15,804.64	16,211,949	1,025
68 Western Pacific.....	1,923.67	920,553	479
SOUTHWESTERN REGION:			
69 Frisco Lines.....	6,785.56	3,831,222	565
70 Kansas City Southern.....	1,440.15	1,391,796	966
71 Louisiana & Arkansas.....	1,005.02	588,596	586
72 Missouri-Kansas-Texas.....	4,685.53	2,183,065	466
73 Gulf Coast Lines.....	1,668.46	578,095	346
74 International-Great Northern.....	1,531.33	458,803	300
75 Missouri Pacific.....	10,490.02	5,388,249	514
76 Texas & Pacific.....	2,710.46	1,360,409	502
77 St. Louis Southwestern.....	2,341.60	1,402,175	599
78 Texas & New Orleans.....	6,131.48	2,761,097	450
Composite Average.....	371,797.04	308,511,831	830
AVERAGES BY REGIONS:			
New England.....	10,930.70	9,665,468	884
Great Lakes.....	50,311.14	49,002,585	974
Central Eastern.....	50,030.70	50,884,116	1,017
Peachontas.....	16,181.96	21,563,089	1,333
Southern.....	56,036.80	44,034,544	786
Northwestern.....	65,390.79	43,409,994	664
Central Western.....	84,125.34	70,008,501	832
Southwestern.....	38,789.61	19,943,537	514

*Represents total tax accruals other than United States Government taxes.

Action Recommended
Acceptance as information.

TRAIN HOUR VALUE*

This revised report outlines a recommended method for determining the value of a train hour using as the basis the average cost items included in Annual Report Form A submitted by Class I railroads to the I.C.C.

The average costs so developed may be adjusted to fit local conditions on any railroad or subdivision under study, giving consideration to the factors which make up the cost of the train hour, taking credit for such of those factors shown in Table I as will be saved in evaluating the saved train hour. To such costs must be added the estimated value of intangibles, some of which are mentioned in this report, in order to obtain total Train Hour Value. Thus, Train Hour Value is comprised of "out-of-pocket" train hour costs, plus the value placed upon intangibles.

When knowing the Train Hour Value (THV) and the train hours saved, the total saving to be effected is the product of the two.

Table I shows account numbers according to I.C.C. classification, page references to locate the items of cost in Annual Report Form A and formula for the final calculation.

TABLE I

Items	I.C.C. Account Classification	Form A Report Reference (1949)
1. Overtime wages.....		{ Page 524 Schedule 561-B
Wages, train and enginemen.....	392-393 & 401	{ Page 309 Schedule 320
2. Train fuel.....	394	
3. Water for train locomotives.....	397	
4. Lubricants for train locomotives.....	398	
5. Other supplies for train locomotives....	399	
6. Enginehouse expenses—train.....	400	
7. Train supplies and expenses.....	402	
8. Locomotive repairs.....	308 & 311	{ Page 307 Schedule 320
9. Locomotive depreciation.....	331	{ Page 313-B Schedule 320-F
	(Sub-accounts 51 & 52)	
10. Interest on locomotive investment.....		
11. Payroll taxes.....		

In addition, the following information must be obtained:

A. Road freight train hours.....	Item 29 Col. B	{ Page 508 Schedule 531
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Formula

$$\text{B. Train Hour Cost} = \frac{\text{Sum of Items 1 to 11}}{\text{Item A}}$$

* Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 44 and 320.

The following explanations refer to the items enumerated in Table I:

ITEM 1—WAGES

Wages are only to be considered when on overtime basis. Generally, records are available on each railroad of actual overtime costs and when available should be used for this item. The following explanations will be useful in cases where it will be necessary to calculate the amount of overtime.

Road freight overtime.

Road employees are paid on the basis of the miles of the train run. If it takes longer than a certain time to run the miles paid for, then overtime is paid in addition to payment for the mileage made.

For all employees in road freight service, "eight hours or less—100 miles or less" constitute a day's work for pay purposes.

In all cases, a basic day's pay is guaranteed, no matter how few miles or hours an employee works. On the other hand, where an employee runs more than his "basic day's mileage" he is paid proportionately for each excess mile run.

Thus, all road freight employees receive a basic day's pay for runs up to 100 miles and are paid for each additional mile run at a rate which is $\frac{1}{100}$ of the basic daily rate.

Road overtime starts on all freight runs where the time on duty exceeds the time obtained by dividing the mileage made by $12\frac{1}{2}$ miles per hour, with a minimum of 8 hours, as shown by the following examples:

Miles	Overtime starts after
90	8 hours
100	8 hours
125	10 hours
135	10 hours 48 minutes
150	12 hours
175	14 hours
180	14 hours 24 minutes

Improved methods of train operation reduce the time of trains on the road and frequently eliminate or reduce overtime wages paid train and engine crews.

The reduction in overtime hours may be forecast by the process of plotting and redispersing train movements.

The reduced number of overtime hours, having been determined for a representative test period, are then projected to an annual basis.

The final step consists of multiplying the overtime hours saved by the overtime rate which determines the annual saving. Where two classes of service are involved (through freight and local freight), the rate applicable to each should be determined and used.

The hourly overtime rate is obtained by dividing the basic daily rate by 8 (hours per day) and multiplying by 1.5.

To the amount thus obtained should be added payroll taxes, railroad retirement and unemployment insurance and, in addition, State taxes in some instances.

Examples of Determining Overtime Rates

Through Freights

Class of employee	No. of employees	Basic daily rate (8 hours)	Total
Engineman	1	\$13.87	\$13.87
Fireman	1	12.03	12.03
Conductor	1	12.06	12.06
Brakemen	2	10.64	21.28

Total basic day train rate.....	\$59.24
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Train hour rate.....	\$ 7.40
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Overtime hourly rate.....	\$11.10
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Add 6 per cent for payroll taxes.....	0.67
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Total overtime hourly rate.....	\$11.77
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Local Freights

Engineman	1	\$14.39	\$14.39
Fireman	1	12.43	12.43
Conductor	1	12.62	12.62
Brakemen	3	11.07	33.21

Total basic day train rate.....	\$72.65
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Train hour rate.....	\$ 9.08
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Overtime hourly rate.....	\$13.62
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Add 6 per cent for payroll taxes.....	0.82
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Total overtime hourly rate.....	\$14.44
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The foregoing figures are typical for an average locomotive and at rates effective October 1, 1948. Each railroad should use rates applicable on the territory involved.

Initial and Final Terminal Delay, Road Freights

Terminal delay on road freight trains may result in arbitrary additional payments for time at the initial and final terminals, depending upon the wage agreements in effect.

If the improved facilities expedite the terminal operations, a check of the initial and final terminal payments should be made to determine the difference in crew wages.

When road overtime accrues during any trip or tour of duty, in no cases will payment for both initial terminal delay and overtime be paid; but that which is the greater will be paid.

In computing road overtime, consideration should be given to the fact that in many cases engine crews are usually on duty from 30 minutes to 45 minutes longer than train crews. If switch tenders or power switches are not employed, the head brakeman is also called on duty early to handle the switches for the engine in and out of the round house leads.

Several centralized traffic control studies have shown that the initial terminal overtime saving has averaged from 10 to 40 minutes per through freight train.

Final terminal delay is computed from the time the engine reaches a designated point either on the main track or in the yard; however, if road overtime has commenced, terminal overtime does not apply; but, instead, road overtime is paid to the point of final relief.

Initial and final terminal delay time must be checked with agreements of each railroad to obtain basis of payment.

ITEM 2—FUEL

Account 394 does not include cost of on-line fuel transportation. An allowance should be made over the listed cost of train fuel to cover cost of its on-line transportation. For the year 1946 this cost averaged 5.31 mills per net ton mile for Class I railroads in the United States. Each railroad can provide its own cost per ton mile. Also, each railroad has a record of its average length of haul.

ITEM 9—LOCOMOTIVE DEPRECIATION

This item should include charges for all road freight locomotives. Reports to the I.C.C. covering these charges are classified as Account 331, Sub-accounts 51 and 52.

Prior to 1949, Annual Report Form A did not provide for separation of charges to these accounts between yard and road freight locomotives, necessitating approximate apportionment on the basis of the ratio of road freight locomotive repairs to total freight locomotive repairs. Beginning with the year 1949, Annual Report Form A provides for separation of Sub-accounts 51 and 52 between yard and road freight locomotives thus permitting direct assignment of depreciation charges for road freight locomotives.

Locomotive retirements.

This item was formerly carried as Account 310 but is eliminated from further consideration because the railroads have discontinued accounting under this classification in accordance with latest prescribed I.C.C. rules. Hereafter charges to I.C.C. Account 331, covering Item 9—Locomotive depreciation, will be sufficient to include what was formerly charged under "Locomotive retirements."

ITEM 10—INTEREST ON LOCOMOTIVE INVESTMENT

Investigation of this item indicates that the present practice is to charge only interest on "Locomotive investment" as is currently paid on the Equipment Trust Certificates. Railroad accounting practices do not provide for separation of these charges. The total amount involved for all classes of equipment in each Equipment Trust Certificate is reported in Annual Report Form A. Each railroad can, of course, separate the amount applicable to road freight locomotives, and the total annual charges for road freight locomotives can thereby be determined. However, since the total annual charge for one representative railroad for 1942 was only \$0.11, this is classified as a minor item, and its value will be omitted from further consideration in this report.

ITEM 11—PAYROLL TAXES

This item should include payroll taxes at the prevailing rate ($6\frac{1}{2}$ per cent in 1949) of all overtime wages for train and enginemen, Item 1, unless included with cost of overtime in Item 1, also labor applicable to Item 6—Enginehouse expenses, and Item 8—Locomotive repairs. The rate for payroll taxes is regulated by Federal law and prescribed to change from time to time, in which event it will, of course, be necessary to change the rate accordingly. The total charges for Item 6 are covered by Account 400, while the total charges for Item 8 are covered by Account 308. These charges are reported in the railroads' Annual Reports Form A without showing separately the cost of labor. It is therefore necessary to separate the labor from the total charges, and while this is more readily obtainable from the railroads' detailed accounts, it can be determined on the basis of assuming the same percentage of labor to total charges shown in Annual Report Form A as has generally prevailed in the past, which is:

- 85 per cent for enginehouse expenses, and
- 70 per cent for road freight locomotive repairs.

ADDITIONAL ITEMS

Costs of double-header, pusher or helper, Diesel and electric propulsion operation are in Items 1 to 11, inclusive, and are not separately shown in Annual Report Form A. Therefore, when it is desired to set up these charges separately or to emphasize what additional expense they may entail, thereby increasing the cost of train hour, it will be necessary that the costs be obtained from the reports of the railroad's particular division where these services are used.

INTANGIBLE ITEMS

Consideration should be given to the following items which, while generally considered intangible, should be evaluated on the basis of local operating conditions:

1. Availability of equipment.
2. Improved service to shippers.
3. Competitive position with other carriers.
4. Value of on-time deliveries, thereby saving penalty of missed market deliveries.

After it has been determined which of the above items are to be considered and the amounts for each have been obtained, the following procedure is necessary to arrive at the Train Hour Value:

1. Total the amounts of Items 1 to and including 11, Table I.
2. The sum of these items to be divided by the amount representing Item A. This result will equal the Train Hour Cost, Item B.
3. To Item B should be added the hourly value of the intangibles to obtain the total Train Hour Value.

The amount of Items 2 to 11, inclusive, is obtainable from Annual Report Form A, as has been explained. For convenience, train hour costs per road freight train hour, Items 2 to 11, have been compiled for the year 1949 by the Bureau of Railway Economics, A.A.R., and are shown in Table II. The table shows system costs for 78 Class I railroads, together with composite average costs for those railroads and average costs by regions.

Inasmuch as the amount of overtime is usually available for individual railroads for the territory involved (but is not shown separately in Report Form A), it has not been included in Table II. If the direct information for overtime is not available, Item 1, Table I, should be determined, as has been explained, and added to the sum of Items 2 to 11 to produce complete train hour cost. Payroll taxes for other than train crew wages are included in Item 11, Column 4, Table II.

For those who desire to use cost figures as prepared on system basis for each railroad to represent the value of the train hour saved, Table II will supply the information with Annual Report Form A as the source but without the necessity of the detailed calculations as has been set up in this report.

To simplify Table II, only the total sum for Items 2 through 8 for cost of Fuel, Supplies, Enginehouse Expense and Locomotive Repairs has been shown in Column 2. In order to show the relative value of these various items a breakdown illustrating the costs of each item for Railroad No. 32 listed in Table II for the year 1949 is as follows:

Railroad No. 32			
Year 1949			
Freight Train Hours (Schedule 531) 919,001			
Item	Account	Freight proportion (Schedule 320)	Cost per freight train hour
2	394 Train fuel.....	\$12,417,925	\$13.51
3	397 Water for train locomotives.....	582,112	0.64
4	398 Lubricants for train locomotives.....	423,176	0.46
5	399 Other supplies for train locomotives	130,043	0.14
6	400 Enginehouse expense—train.....	2,776,140	3.02
7	402 Train supplies and expenses.....	4,298,352	4.68
8	308 Steam locomotive repairs—road		
	freight.....	12,141,472	13.21
	311 Other locomotive repairs—road		
	freight.....	204,488	0.22
Total.....		\$32,973,708	\$35.88

Freight train proportion of costs, Schedule 320, divided by the number of Freight Train Hours, Schedule 531, equals the cost per freight train hour for each of the items. This is the procedure outlined in the Formula in Table I.

TABLE II
Specified Elements of Train Hour Cost
per Road Freight Train Hour—Year 1949
(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight locomotive depreciation	Payroll taxes on labor applicable to road freight locomotive repairs and enginehouse expense a	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
NEW ENGLAND REGION:				
1 Bangor & Aroostook.....	\$22.14	\$4.26	\$0.33	\$26.73
2 Boston & Maine.....	22.93	1.07	0.47	24.47
3 Central Vermont.....	27.53	1.04	0.49	29.06
4 Maine Central.....	21.60	0.41	0.43	22.44
5 New York, New Haven & Hartford.....	30.71	2.67	0.63	34.01
6 Rutland.....	28.06	0.69	0.49	29.24
GREAT LAKES REGION:				
7 Grand Trunk Western.....	31.40	1.66	0.45	33.51
8 Erie (Incl. Chgo. & Erie).....	32.96	2.29	0.70	35.95
9 New York, Chgo. & St. Louis (Incl. W. & L. E.).....	36.26	0.33	0.61	37.20
10 Delaware & Hudson.....	56.47	2.17	1.26	59.90
11 Delaware, Lackawanna & Western.....	29.90	2.88	0.51	33.29
12 Lehigh & New England.....	11.55	4.05	0.18	15.78
13 Lehigh Valley.....	36.77	4.07	0.59	41.43
14 Monongahela.....	17.61	1.28	0.35	19.24
15 New York, Ontario & Western.....	16.80	3.93	0.41	21.14
16 New York Central (Incl. B. & A.).....	32.25	1.87	0.63	34.75
17 Pittsburgh & Lake Erie.....	49.00	1.55	0.79	51.34
18 Ann Arbor.....	24.25	0.64	0.46	25.35
19 Wabash.....	31.82	1.49	0.54	33.85
CENTRAL EASTERN REGION:				
20 Baltimore & Ohio.....	32.56	1.35	0.71	34.62
21 Bessemer & Lake Erie.....	99.42	4.49	2.88	106.79
22 Chicago & Eastern Illinois.....	23.39	1.71	0.38	25.48
23 Chicago, Indianapolis & Louisville.....	24.37	3.06	0.50	27.93
24 Detroit, Toledo & Ironton.....	25.48	1.43	0.40	27.31
25 Elgin, Joliet & Eastern.....	12.47	2.24	0.24	14.95
26 Illinois Terminal.....	11.28	1.01	0.20	12.49
27 Long Island.....	20.78	1.25	0.36	22.39
28 Pennsylvania.....	34.08	2.29	0.66	37.03
29 Cent. RR of New Jersey (Incl. C.R.R. of Pa.).....	38.40	3.14	0.68	42.22
30 Reading.....	30.77	1.78	0.62	33.17
31 Western Maryland.....	46.01	3.12	1.07	50.20
POCAHONTAS REGION:				
32 Chesapeake & Ohio (Incl. Pere M.).....	35.88	2.23	0.72	38.83
33 Norfolk & Western.....	45.38	2.14	0.85	48.37
34 Richmond, Fred'burg & Potomac.....	53.41	1.66	1.00	56.07
35 Virginian.....	36.18	4.22	0.82	41.22
SOUTHERN REGION:				
36 Atlantic Coast Line.....	25.11	1.25	0.42	26.78
37 Clinchfield.....	36.88	3.52	0.79	41.19
38 Louisville & Nashville.....	26.50	0.74	0.55	27.79
39 Nashville, Chattanooga & St. Louis.....	22.25	2.13	0.37	24.75
40 Florida East Coast.....	26.39	3.58	0.45	30.42
41 Gulf, Mobile & Ohio (Incl. Alton).....	29.55	5.61	0.67	35.83
42 Central of Georgia.....	26.09	0.94	0.46	27.49
43 Illinois Central (Incl. Y. & M. V.).....	27.01	1.06	0.48	28.55
44 Norfolk Southern.....	17.29	2.03	0.41	19.73
45 Seaboard Air Line.....	29.96	1.81	0.58	32.35
46 Alabama Great Southern.....	35.32	4.03	0.76	40.11
47 Cincinnati, New Orleans & Tex. Pac.....	35.62	2.49	0.78	38.89
48 Southern.....	27.63	3.10	0.60	31.33

a Payroll taxes calculated at rate of 6 per cent. Reduction from actual rate of 6.50 per cent account compensation in excess of \$300 per month.

TABLE II—Continued

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight locomotive depreciation	Payroll taxes on labor applicable to road freight locomotive repairs and enginehouse expense a	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
NORTHWESTERN REGION:				
49 Mpls., St. P. & S. S. Marie (Incl. Wis. C.)....	\$26.39	\$1.61	\$0.46	\$28.46
50 Chicago & North Western.....	24.27	1.89	0.42	26.58
51 Chicago, St. Paul, Mpls. & Omaha.....	23.16	0.56	0.31	24.03
52 Chicago Great Western.....	18.44	4.80	0.24	23.48
53 Chicago, Milwaukee, St. Paul & Pac.....	26.63	1.03	0.46	28.12
54 Duluth, Missabe & Iron Range.....	60.93	0.71	1.26	62.90
55 Great Northern.....	29.71	1.35	0.56	31.62
56 Minneapolis & St. Louis.....	17.62	2.05	0.38	20.05
57 Northern Pacific.....	30.04	1.55	0.59	32.18
58 Spokane, Portland & Seattle.....	22.94	1.81	0.39	25.14
CENTRAL WESTERN REGION:				
59 Atchison, Topeka & Santa Fe.....	32.23	1.46	0.64	34.33
60 Chicago, Burlington & Quincy.....	22.45	0.58	0.32	23.35
61 Colorado & Southern.....	29.27	0.50	0.54	30.31
62 Fort Worth & Denver City.....	22.22	0.39	0.36	22.97
63 Denver & Rio Grande W. (Incl. D. & S. L.)..	40.34	2.80	0.81	43.95
64 Rock Island System.....	22.12	1.41	0.40	23.93
65 Northwestern Pacific.....	16.06	0.37	0.30	16.73
66 Southern Pacific.....	41.80	1.79	0.91	44.50
67 Union Pacific.....	42.00	3.30	0.73	46.03
68 Western Pacific.....	38.55	2.57	0.77	41.89
SOUTHWESTERN REGION:				
69 Frisco Lines.....	25.54	2.22	0.39	28.15
70 Kansas City Southern.....	32.84	2.37	0.60	35.81
71 Louisiana & Arkansas.....	26.59	1.91	0.46	28.96
72 Missouri-Kansas-Texas.....	21.02	1.79	0.36	23.17
73 Gulf Coast Lines.....	22.53	1.51	0.38	24.42
74 International-Great Northern.....	23.99	1.68	0.44	26.11
75 Missouri Pacific.....	25.75	2.01	0.48	28.24
76 Texas & Pacific.....	36.33	2.41	0.58	39.32
77 St. Louis Southwestern.....	25.82	0.94	0.42	27.18
78 Texas & New Orleans.....	28.65	0.86	0.58	30.09
Composite Average.....	31.15	1.84	0.60	33.59
AVERAGES BY REGIONS:				
New England.....	25.96	1.73	0.51	28.20
Great Lakes.....	33.41	1.87	0.63	35.91
Central Eastern.....	33.01	2.00	0.67	35.68
Poconantas.....	39.17	2.33	0.77	42.27
Southern.....	27.38	1.86	0.54	29.78
Northwestern.....	27.18	1.50	0.49	29.17
Central Western.....	34.10	1.83	0.65	36.58
Southwestern.....	26.56	1.74	0.47	28.77

a Payroll taxes calculated at rate of 6 per cent. Reduction from actual rate of 6.50 per cent account compensation in excess of \$300 per month.

Action Recommended

Acceptance as information.

GRADE AND TONNAGE SIGNALS

Summary of Economic Advantages

The extensive use of grade or tonnage signals in connection with Stop and Proceed signals on a number of railroads indicates that, where local operating conditions warrant, these special signals will provide the following operating and economic advantages:

1. Eliminate unnecessary train stops at Stop and Proceed signals.
2. Eliminate the possibility of trains stalling on heavy grades.
3. Eliminate the possibility of damage to equipment due to restarting of trains on heavy grades.
4. Increase track capacity on account of permitting closer following train movements.
5. Increase the average train speed due to the elimination of the unnecessary train stop.
6. Avoid stopping trains where one or more busy streets or highways would be blocked.

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Action Recommended

Acceptance as information.

HIGHWAY GRADE CROSSING PROTECTION

Summary of Economic Advantages

The following are some of the combinations of installations used to provide highway grade crossing protection:

1. Flashing light signals: automatic operation.
2. Flashing light signals: automatic operation with superimposed manual control.
3. Flashing light signals: manually controlled.
4. Flashing light signals and automatic gates: automatically controlled.
5. Flashing light signals and automatic gates: automatically controlled with manual supervision.
6. Flashing light signals and automatic gates: manually controlled.
7. Electric gates: manually controlled.

Control of the foregoing sometimes includes full manual control or supervisory control of several crossings from one point.

Some of the factors to be considered are:

1. On single-track railroads, where physical conditions permit, an installation of flashing light signals will provide improved protection.
2. On multiple-track railroads, where physical conditions permit, flashing light signals with automatic crossing gates will provide improved protection.
3. In either of the above, local conditions must be analyzed and where extensive switching is prevalent or station stops are involved, an installation which includes automatic control with manual supervision may be required.

4. Individual crossings or groups of crossings may require special consideration and supplementary means provided to insure satisfactory protection and operation.

5. Combinations of automatic, manually supervised or manual operation may be used advantageously for a group of crossings.

6. Where automatic control is not feasible, two or more crossings may be protected by manual control of crossing protection from a single point.

The economic savings of a number of installations show the following:

One installation flashing light signals—11 crossings—18 per cent saving.

One installation—14 highway crossings—flashing light signals—58.7 per cent saving.

Installations at 246 crossings on 21 railroads show savings from 10.1 per cent to 175 per cent, and an average saving of 46.9 per cent.

An installation of flashing light signals and short arm gates with automatic protection for main tracks, manual protection for other tracks including installation of color light dwarf signals on some tracks which are interlocked with the crossing protection—43 per cent saving.

Installation of flashing light signals and short arm gates with part time manual supervision—38.1 per cent saving.

An installation of flashing light signals and automatic gates at five crossings with manual supervision part time provided for the elimination of speed restrictions—saving 30.58 per cent.

Forty-five crossings with flashing light signals and short arm gates on eight railroads showed a saving of 9 per cent to 218 per cent—average 62 per cent.

An installation at 13 crossings, flashing light signals and short arm gates replacing manual protection—saving 84.07 per cent.

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Action Recommended

Acceptance as information.

CAR RETARDERS

Summary of Economic Advantages

In 1949 there were 66 car retarder installations in service by 30 railroads or companies. In 1945, 19 of these railroads reported advantages and savings as follows:

Eliminates car riders and reduces number of switch tenders.

Reduced delays.

Expedited peak car movements during rush hours.

Reduced time of cars in yard 50 per cent.

Saved on investment from 24.8 to 50 per cent.

Effectuated a large saving in switching cost.

Saving varied from 10 to 40 cents per car handled.

Materially expedited traffic at busy terminal.

Reduced switching at other yards.

Expedited classifications.

Reduced yard cost 27.5 per cent.

Increased cars humped per hour by 14 per cent.

Capacity of yard increased 50 per cent.

Reduced damage to cars and lading.

Expedited perishable freight.

Other advantages are:

1. Possibility of keeping a yard in operation under severe weather conditions.

2. Elimination of tracks, motor cars and concrete subways for returning riders to hump or the utilization of such tracks for additional classification tracks.

3. All delays waiting for riders to return to hump are removed.

4. Practically eliminates personal injuries.

5. Permits faster freight schedules and better connections.

6. Permits clearing the receiving yard in a shorter time, resulting in an increased capacity of the yard, without providing additional receiving tracks.

7. Permits reduction in motive power.

8. Increases car miles per car day and reduces per diem.

9. Eliminates the problem of securing car riders.

10. Provides increased flexibility of operation for meeting varying traffic conditions.

11. Permits classifications at one central point rather than at several locations.

12. Has proven of economical advantage at low traffic density.

13. Reduces engine and crew hours.

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Action Recommended

Acceptance as information.

MANUALLY OPERATED INTERLOCKINGS

Summary of Economic Advantages

The first interlocking plant in America was installed February 11, 1875, on the Pennsylvania R.R., at a junction in East Newark, N. J.

During the past 75 years several thousand interlockings have been installed in the United States and Canada.

The manually operated type of interlocking is in general use on most railroads for providing safety and for expediting the movement of traffic at railroad crossings, terminals, junctions, drawbridges, gauntlets, main line crossover layouts, entrance to yards, switching layouts, etc., where no method of automatic operation is suitable but where traffic and local operating conditions require the services of an attendant for manipulating the functions of the interlocking in their proper sequence. Operating and economic advantages derived from the use of manually operated interlockings on a large number of railroads are as follows:

1. Improved safety.
2. Elimination of train stops and delays.
3. Elimination of pusher service due to stalled trains and break-in-two's.
4. Increased speed of trains.
5. Operation of trains with additional tonnage under adverse grade conditions.
6. Operation of single and multiple track lines up to their full capacity.
7. Economies effected usually more than offset the cost of operation and maintenance, resulting in a net savings equivalent to a return on capital investment ranging from 10 to over 100 per cent.

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Action Recommended
Acceptance as information.

AUTOMATIC INTERLOCKINGS

Summary of Economic Advantages

The practice of installing automatic interlockings was started on the Western railroads about 1921. The results were so satisfactory that their use was expanded rapidly and about 243 such installations were made on 40 railroads in the 5-year period, 1925 to 1930.

This general practice on a number of railroads to install automatic interlockings at railroad grade crossings so as to eliminate stops at crossings where trains were previously required to make safety stops, as well as for replacing manually operated interlockings at railroad grade crossings, gauntlets, or junctions in order to reduce operating and maintenance expense indicates that, where local operating conditions permit, automatic interlockings will provide the following operating and economic advantages:

1. Elimination of train stops at unprotected railroad grade crossings.
2. Increased speed of trains due to train stops eliminated at unprotected crossings resulting in faster schedules over the division. The time saving will vary with the grade and local operating conditions which variation may be from 5 to 15 minutes or more per stop saved.
3. Elimination of train stops also reduces fuel consumption and the wear and tear on equipment, and results in a general improvement in train operation especially in the case of heavy trains.
4. Increased safety of train operation as trains are protected by modern signal devices which give information as to actual track conditions.
5. When modern signal devices replace existing interlockings, operating expenses are reduced due to a saving in the cost of maintaining and operating the old facilities, including the upkeep of the tower buildings.
6. Automatic interlocking at a railroad grade crossing in non-automatic signaled territory will fit in with automatic block signals and centralized traffic control when installed.
7. When a railroad grade crossing is located at a point where train starting conditions are unfavorable, elimination of train stops may permit the handling of additional tonnage.
8. Avoiding crossing delays or train stops may mean that freight trains can make longer runs without stopping for coal and water.
9. It may be possible for dispatchers to make closer meets on single track and easier for trains to make up lost time.
10. It is the most economical type of complete signal protection which can be provided for a railroad grade crossing, gauntlet track or junction layout.
11. It is estimated that a time saving of 14 minutes per day, or a minimum of two train stops per day, will pay the operating charges of an automatic interlocking.
12. Automatic interlockings after nearly 20 years of service under railroad operating conditions on light as well as heavy traffic railroads have been found to be reliable and economical.
13. Automatic interlockings have proven to be one of the best money-saving devices which the railroads can install. The savings will usually pay the cost of installation within a reasonable period, and the return on investment varies from 19 to over 100 per cent.

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Action Recommended
Acceptance as information.

CONSOLIDATION OF INTERLOCKINGS

Summary of Economic Advantages

Originally the distance between an interlocking machine and operated switch was limited by the length of pipe line it was practical to operate. This resulted in the installation of many interlockings close together. The development of the electric switch machine made it practical to consolidate interlockings from 1,400 feet to 5.8 miles apart, and to provide economies from 12 to 101 per cent.

Operating and economic advantages on a large number of railroads are as follows:

1. Increased safety.
2. Improved train operation.
 - (a) Due to control from a central point.
 - (b) Elimination of train stops at intermediate hand-thrown switches which were operated.
3. Decreased operating expense.
 - (a) Man hours for operators.
 - (b) Elimination of train stops.
 - (c) Reduce train hours.
 - (d) Maintenance of one or more towers.
4. Reduced time clearing highway grade crossings.

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Action Recommended
Acceptance as information.

REMOTE CONTROL

Summary of Economic Advantages

Remote control is a term applied to a method of operating outlying signal appliances from a designated point. It is used to advantage where switches are located some distance from a station, at an end of two main tracks, junction, railroad crossing at grade, or at entrance to a yard where an operator at a nearby station can control the position of the switches and signals to allow trains to proceed without stopping or reducing speed below that specified in the rules.

It is used to replace a remote interlocking to avoid extensive expense for rehabilitation and for operation of switches which have been handled by switchmen. Distance from control point has relatively small effect on the economies to be gained. The number of remote control installations in service on January 1, 1945 was 486.

Operating and economic advantages of 37 installations on a number of railroads show an average of 31.9 per cent and are as follows:

1. Reduction in delay time due to train stops eliminated.
2. Reduction in cost of train operation.
3. Reduction in cost of maintaining and operating block or interlocking stations.
4. Increased safety of train operation.
5. Increased capacity.
6. Increased on-time performance.
7. Deferring more expensive alternative improvements.

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Action Recommended
Acceptance as information.

AUTOMATIC BLOCK SIGNALS

Summary of Economic Advantages

The foundation of automatic block signaling was laid in 1872, at which time the track circuit was invented. Between that time and 1950, a total of 108,052 miles of track has been protected by this kind of signaling.

The economy of train operation in an automatic block system results from:

1. Increasing track capacity up to 55 per cent.
2. Saving up to 45 per cent in operating costs.
3. Increasing train speeds with safety.
4. Reducing delays at meeting points on single track.

5. Reducing number of train orders.
6. Reducing damage to equipment and lading due to reduction in number of stops.

7. Deferring more expensive alternative improvements.

Other intangible benefits are due to protection against track occupancy, open switch, broken rails and in some cases slides.

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Action Recommended

Acceptance as information.

ECONOMICAL TRAIN PERFORMANCE ON SINGLE TRACK INCLUDING TRAIN CAPACITY ON SINGLE TRACK

Summary of Economic Advantages

Actual operation of 42 to 70 trains per day has been accomplished on several single-track lines, and studies made on a number of railroads indicate that more than 100 trains may be operated, depending upon various local operating factors.

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Action Recommended

Acceptance as information.

ELECTRIC LIGHTING OF SIGNAL AND SWITCH LAMPS

Summary of Economic Advantages

Use of oil for signal lights steadily declined since prior to 1924, and so far as published information is available, oil lamps for signal lighting are no longer being installed.

Many years ago it was extremely difficult to obtain comparative cost figures for electric vs. oil lights primarily because the roads did not seem to keep record of such costs. However, about 1929 one railroad reported a net annual saving of \$4.32 per lamp by use of electric (battery) compared to oil lighting. About 1939 another railroad by using reclaimed material for lamp cases and available battery jars saved \$1.066 per month per lamp, or \$12.79 annually by using electric lights operated from primary battery as compared with cost of oil operated.

Cost of electric lighting of switch lamps is about as uncertain as for the signal lamps due primarily to lack of records. There is, however, record of three cases which appear to be representative of the two types of lighting, *i.e.*, by battery or by purchased electric power. In 1922, the Nashville, Chattanooga & St. Louis Ry. converted 170 oil burning lights to 110-volt commercial alternating current in one yard and effected a net saving of \$1,411 by an expenditure of \$2,788, or approximately 50 per cent over and above 6 per cent interest charges. In another Nashville, Chattanooga & St. Louis Ry. yard in 1923, 70 oil burning lamps were converted to 110-volt commercial alternating current at a net saving of \$712 on an expenditure of \$1,929, equaling 36.9 per cent over and above 6 per cent interest charges.

In 1920, the Western Maryland R.R. converted 224 oil burning lights to electric operation from primary batteries. The net annual saving in this case being \$2,036 for an expenditure of \$4,725, realizing an annual return of 43 per cent over and above 6 per cent interest charges.

While electric lighting of signal lamps has been a reality for many years, electric lighting of switch lamps has not progressed to anywhere near the same extent. Where installed, they have proved to be economical. At the present time, however, due to the high cost of labor and the 40-hour week, much importance has been attached to the need of electric lights for switches. Also, the manufacturers, realizing this need, are preparing suitable material for battery lighting of switch lamps so it is to be expected that much more progress will be made due to the economies to be effected.

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Action Recommended

Acceptance as information.

TRAIN OPERATION BY SIGNAL INDICATION

Summary of Economic Advantages

Train operation by signal indication was first put into successful use in 1882 at Louisville, Ky. This installation was on 8 miles of single track with 6 manual block sections and including a single-track bridge over the Ohio River. Trains of 4 railroads, totaling 150 daily, were directed by signal indications given under instruction of the dispatcher and without use of train orders.

This installation led to others, but it was not until 1907, following an installation made on a single-track line with track circuits for controlling the manually operated signals, that this method of operation fully established its efficiency and reliability as a means of directing train movements without train orders on single-track lines.

Train operation by signal indication without train orders on multiple-track lines with the current of traffic also was used as early as 1888 under conditions similar to single-track operation.

In 1927 another advance in train operation by signal indication was made. At that time the New York Central R.R. on 40 miles—37 miles of single track and 3 miles of two tracks—from Stanley, Ohio (south of Toledo, Ohio) to Berwick, Ohio, installed the first system of what today is known as centralized traffic control. In this installation the dispatcher was given direct control of the switches and signals, and the movement of trains was governed entirely by signal indication without train orders.

By 1929 there were 167 installations on 41 railroads in the United States and Canada operating trains by signal indication without train orders. These installations comprised 819 miles of single track and 1,430 miles of multiple track (either-direction operation), a total of 2,249 track miles.

Train operation by signal indication is of benefit to and reduces delays to both passenger and freight trains. However, passenger trains being first-class usually receive preferred attention and for that reason may not benefit to the same extent as freight trains.

Checks made of freight train time saved on 41 installations show variation from 0.27 minute to 4.29 minutes, with an average of 0.94 minute per freight train mile.

The advantages of train operation by signal indication include:

1. Elimination of train orders.
2. Better supervision of train operation by dispatcher.
3. Reduction in train delays.
4. Reduction of train stops.
5. Faster train schedules.
6. Increased track capacity.
7. Increased safety.
8. Increased over-all efficiency of operation.
9. Postponement of installation of additional track.
10. Reduced cost of operation.

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- A.R.A. Signal Section 1925 Proceedings, Vol. XXIII, pp. 130, 239 and 595.
- A.R.A. Signal Section 1927 Proceedings, Vol. XXV, pp. 49, 336, 359, 808 and 819.
- A.R.A. Signal Section 1929 Proceedings, Vol. XXVII, pp. 266 and 329.
- A.R.A. Signal Section 1930 Proceedings, Vol. XXVIII, pp. 281, 287, 292, 297, 362, 364 and 367.
- A.A.R. Signal Section 1936 Proceedings, Vol. XXXIV, pp. 51, 61, 432, 438 and 447.
- A.A.R. Signal Section 1939 Proceedings, Vol. XXXVII, pp. 40 and 551.
- A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, pp. 58 and 291.
- A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 47-A and 333-A.
- A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 37, 55, 467 and 468.
- A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 16, 56, 318 and 320.

Action Recommended

Acceptance as information.

CENTRALIZED TRAFFIC CONTROL

Summary of Economic Advantages

The first installation of centralized traffic control was made on the New York Central R.R. in 1927. It comprised 37 miles of single track and 3 miles of two tracks—from Stanley, Ohio (south of Toledo, Ohio), to Berwick, Ohio.

In this installation, the dispatcher was given direct control of the switches and signals, and the movement of trains was governed entirely by signal indication without train orders.

By 1929 there were 167 installations on 41 railroads in the United States and Canada operating trains by signal indication without train orders. These installations comprised 819 miles of single track and 1,430 miles of multiple track (either-direction operation), a total of 2,249 track miles.

The I.C.C. Statistics, January 1, 1950, showed the following methods and mileage in use for operating trains by centralized traffic control:

Method of operating trains	Road	Miles of Track
One-direction operation by signal indication.....	61.4	126.0
Either-direction operation by signal indication.....	11,040.3	12,186.8
Total	11,101.7	12,312.8

The advantages of train operation by centralized traffic control include:

1. Elimination of train orders and the possibility of errors in issuing, transmitting, interpreting and executing train orders.

2. Better supervision of train operation is obtained by the dispatcher, as changing traffic conditions are immediately reflected on his operating board. This enables the dispatcher to change the line-up of train operation with increased facility and safety.

3. Train delays are also reduced, as experience shows that many meets on single track are so well timed that neither train stops.

4. Capacity of the line is increased by the use of power switches and the more frequent and accurate OSing of the passage of trains through the 24 hours which makes it possible for the dispatcher to change his scheme of operation as traffic conditions permit.

5. Increased safety is obtained where power-operated switches are used because:

- (a) Reduction in number of stops results in less wear and damage to equipment and, consequently, there is less chance of accidents and personal injury.

- (b) Power switches may be used to route trains around obstructed track and may serve to give derail protection to train standing on the main track awaiting a meet.

- (c) Eliminates chances of personal injury to trainmen running ahead of train to open switch, in operating switch, or running to catch train after closing switch.

- (d) Trains are kept in motion a greater portion of the time, and the chances of collisions are reduced.

6. Instructions governing the movement of trains are given by signal indications displayed at the point where action is required, by the control operator

to the engineman, eliminating intermediary action by other employees. This concentration of control of train movements eliminates individual judgment which cannot always coordinate to the best advantage in the most expeditious and safe movement of trains.

7. It provides additional protection for a train working between switches at end of sidings, as often other trains can be run around the working train. This form of operation may, in many cases, permit the elimination of yard limits.

8. It provides controlled signals at many points which may be used by the control operator to stop trains when employees report dragging or defective equipment or other unsafe conditions.

9. Its operation shortens the running time over the territory and, consequently, reduces the number of meets per trip, thereby reducing the possibility of accidents.

10. It has brought about a higher standard of maintenance of switches and sidings, increasing safety of operation.

11. Additional protection can be given for the movement of track cars and other maintenance-of-way department equipment, as the control operator can protect these movements by signals.

12. Because there is less standing time on sidings, the "freezing up" of trains in cold weather is less likely to occur.

13. It provides greater safety at times of peak business, as the control operator can more efficiently direct increased traffic.

14. It increases safety by eliminating the necessity of checking train register and identifying trains at meeting points.

15. It increases the over-all efficiency of operation by placing the entire control of trains under the dispatcher.

16. It obviates the immediate need for additional trackage, by increasing the capacity of existing track facilities.

17. It permits reduction of main track and sidings by increasing capacity of the remaining track facilities.

18. It reduces the cost of operation by releasing switchmen and operators.

19. It increases availability of locomotives, cars and operating personnel.

Bibliography

- A.R.A. Signal Section 1927 Proceedings, Vol. XXV, pp. 359 and 808.
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A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 16, 56, 318 and 320.

Action Recommended

Acceptance as information.

SPRING SWITCHES

Summary of Economic Advantages

Spring switches were first installed about 50 years ago. This type of switch found early favor on street and electric railways where it was used at ends of two tracks and sidings to eliminate stops to open and close switches. Because of lightweight cars and short trains, as well as comparatively low speeds, a spring switch of this type was perfectly satisfactory from the standpoint of safety. They were, however, used only to a limited extent on steam railways, where they were considered satisfactory only for use in yards and on light traffic lines.

About 1918, a spring switch with a buffer arrangement was designed to prevent the pounding and excessive wear on the switch points caused by heavy passenger and freight trains trailing through the switch. Since then, the spring switch has come into general use on railroads until now there are over 6,600 in service.

Before the addition of the facing point lock as an integral part of the spring switch, some railroads were unwilling to install spring switches on high-speed main lines where facing point moves are made. Where spring switches are installed on high-speed lines, there is now an increasing trend toward equipping them with facing point locks.

Some of the advantages that are derived from these spring switch installations are as follows:

1. Reduces the number of switchmen, or operators.
2. Reduces train delays by eliminating train stops.
3. Increases train tonnage and gross ton miles per train hour.
4. Increases track capacity by eliminating train stops.
5. Increases train speed by eliminating train stops; each stop eliminated advances the train movement by approximately 7 minutes.
6. Reduces fuel consumption and wear on equipment by eliminating train stops.
7. Economies effected will result in savings equivalent to a return on capital investment ranging from 40 to 300 per cent.

Bibliography

A.R.A. Signal Section 1933 Proceedings, Vol. XXXI, pp. 32 and 397.

Action Recommended

Acceptance as information.

CONCLUSIONS AND FINDINGS

Because this subject-matter serves no useful purpose, the Committee recommends that it be removed from the Manual.

Action Recommended

Acceptance for submission to letter ballot for removal from the Manual. (Manual Part 103.)

TRACK AND ROADWAY MAINTENANCE EXPENSES—
PER EQUATED TRACK MILE*

Annual saving in operating expenses, due to retirement of track, switches, and other track appliances, varies with local conditions on each project.

In its investigation of this assignment, the Committee, through cooperation with the Bureau of Railway Economics, A.A.R., has secured information showing track and roadway maintenance expenses per equated track mile (running tracks) and traffic density, on each of 78 railroads for the year 1949, as shown in Table I. This data was developed from Annual Report Form A of each railroad.

The term, "equated track miles," shown in Column I of Table I, for each railroad, is based on a weight of 100 for first main track and 80 for additional main track, passing tracks, crossovers and turnouts operated following A.R.E.A. practice but excluding way and yard switching tracks. The mileage operated under trackage rights is excluded.

The track and roadway maintenance expenses per equated track mile shown for each railroad includes only charges to operating expense for maintenance of running tracks, Accounts Nos. 202, 208, 212, 214, 216, 218, 220, and total charges, Accounts Nos. 269, 270, 271, 272 and 274. Charges to accounts not affected by the elimination or the change in classification of a track have been omitted.

The amount shown per equated track mile represents equivalent expense for one mile of first main track. Expense per mile of additional main track and per mile of passing tracks may be computed as 80 per cent of this amount.

As traffic density, *i.e.*, gross ton miles per mile of road, is an important factor in rail renewal, the last column of Table I shows the tonnage data for each railroad. It represents gross ton miles, including locomotive and tender, for freight and passenger service mile of first main track.

The track and roadway maintenance expense per equated track mile varies from a minimum of \$1,043 to a maximum of \$8,469 with a composite average of \$2,737 for the 78 railroads.

Where signaling improvements result in track retirements, and the estimated saving in operating expenses cannot be obtained on a project, the information shown in Table I may help in arriving at an estimated saving per year.

* Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 61 and 321.

Sept. 1951]

Com. I—Economics of Ry. Signaling

TABLE I
Track and Roadway Maintenance Expenses per Equated
Track Mile (Running Tracks) and Traffic Density
Calendar Year 1949

Railroad	Equated track miles (running tracks) a	Track and roadway maintenance expenses		Gross ton-miles per mile of road (traffic density) d (000)
		Total b	Per equated track mile c	
NEW ENGLAND REGION:				
1 Bangor & Aroostook.....	660.75	\$2,051,706	\$3,105	2,462
2 Boston & Maine.....	2,233.38	6,245,084	2,796	6,819
3 Central Vermont.....	394.72	1,050,249	2,661	4,127
4 Maine Central.....	1,068.76	2,790,221	2,611	3,397
5 New York, New Haven & Hartford.....	2,495.83	8,172,119	3,274	9,179
6 Rutland.....	438.05	590,230	1,347	2,551
GREAT LAKES REGION:				
7 Grand Trunk Western.....	1,292.22	4,265,413	3,301	8,158
8 Erie (Incl. Chgo. & Erie).....	3,355.01	11,120,600	3,315	13,033
9 New York, Chgo. & St. Louis (Incl. W.&L.E.).....	2,605.36	9,850,537	3,781	11,275
10 Delaware & Hudson.....	1,001.72	3,614,987	3,609	13,071
11 Delaware, Lackawanna & Western.....	1,532.80	5,444,668	3,552	13,341
12 Lehigh & New England.....	183.88	657,481	3,576	3,746
13 Lehigh Valley.....	1,777.82	5,045,357	2,838	9,193
14 Monongahela.....	198.48	389,232	1,961	5,529
15 New York, Ontario & Western.....	532.20	555,036	1,043	2,388
16 New York Central (Incl. B. & A.).....	15,005.81	42,066,598	2,803	12,286
17 Pittsburgh & Lake Erie.....	380.13	2,651,583	6,975	16,144
18 Ann Arbor.....	320.60	844,971	2,636	4,673
19 Wabash.....	2,561.15	7,306,342	2,853	8,378
CENTRAL EASTERN REGION:				
20 Baltimore & Ohio.....	7,901.09	24,563,013	3,109	11,519
21 Bessemer & Lake Erie.....	333.78	1,425,057	4,269	16,468
22 Chicago & Eastern Illinois.....	988.33	1,862,415	1,884	5,672
23 Chicago, Indianapolis & Louisville.....	568.36	1,518,347	2,671	5,413
24 Detroit, Toledo & Ironton.....	477.07	1,167,534	2,447	3,832
25 Elgin, Joliet & Eastern.....	279.76	1,346,533	4,813	12,504
26 Illinois Terminal.....	507.17	995,839	1,964	2,209
27 Long Island.....	579.84	2,409,327	4,155	9,885
28 Pennsylvania.....	14,855.14	51,064,183	3,437	15,412
29 Cent.R.R. of New Jersey (Incl. C.R.R. of Pa.).....	838.02	3,158,209	3,769	10,153
30 Reading.....	2,147.45	5,368,390	2,500	11,338
31 Western Maryland.....	877.79	2,901,948	3,306	7,892
POCAHONTAS REGION:				
32 Chesapeake & Ohio (Incl. Pere M.).....	5,738.12	22,672,321	3,951	12,069
33 Norfolk & Western.....	2,973.22	12,855,337	4,324	16,765
34 Richmond, Fred'burg & Potomac.....	240.75	2,038,820	8,469	36,624
35 Virginian.....	718.78	1,946,519	2,708	9,970
SOUTHERN REGION:				
36 Atlantic Coast Line.....	6,335.57	14,802,367	2,336	5,256
37 Clinchfield.....	329.51	1,651,087	5,011	10,365
38 Louisville & Nashville.....	5,627.17	14,569,095	2,589	7,900
39 Nashville, Chattanooga & St. Louis.....	1,205.92	3,622,571	3,004	6,197
40 Florida East Coast.....	945.97	2,933,923	3,101	8,394
41 Gulf, Mobile & Ohio (Incl. Alton).....	3,020.44	8,194,710	2,713	4,637
42 Central of Georgia.....	1,925.02	3,720,915	1,933	4,309
43 Illinois Central (Incl. Y. & M. V.).....	7,912.43	26,357,247	3,331	8,129
44 Norfolk Southern.....	748.50	1,311,414	1,752	2,023
45 Seaboard Air Line.....	4,633.19	13,430,804	2,899	6,558
46 Alabama Great Southern.....	416.29	1,653,624	3,972	11,139
47 Cincinnati, New Orleans & Tex. Pac.....	582.42	3,212,038	5,515	23,017
48 Southern.....	6,902.65	18,027,698	2,612	6,671

a Based on a weight of 100 for first main track, 80 for additional main track, passing tracks, crossovers, and turnouts operated; mileage operated under trackage rights is excluded.

b Includes charges for maintenance of running tracks to Operating Expense Accounts 202, 208, 212, 214, 216, 218, 220, and total charges to Accounts 269, 270, 271, 272, and 274.

c Represents equivalent expense for one mile of first main track. Expense per mile of additional main track, passing tracks, crossovers, and turnouts may be computed as 80 per cent of this amount.

d Represents gross ton-miles (including locomotive and tender) freight and passenger service per mile of first main track.

TABLE I—Continued

Railroad	Equated track miles (running tracks) a	Track and roadway maintenance expenses		Gross ton-miles per mile of road (traffic density) d (000)
		Total b	Per equated track mile c	
NORTHWESTERN REGION:				
49 Mpls., St. P. & S. S. Marie (Incl. Wis. C.)....	4,356.99	\$6,901,854	\$1,584	3,085
50 Chicago & North Western.....	9,179.56	15,774,895	1,718	4,512
51 Chicago, St. Paul, Mpls. & Omaha.....	1,813.52	2,843,093	1,568	3,841
52 Chicago Great Western.....	1,538.00	4,852,856	3,155	5,203
53 Chicago, Milwaukee, St. Paul & Pac.....	11,489.54	19,209,727	1,672	4,753
54 Duluth, Missabe & Iron Range.....	746.64	3,394,666	4,547	10,465
55 Great Northern.....	8,850.54	25,116,829	2,838	5,515
56 Minneapolis & St. Louis.....	1,381.62	2,398,722	1,736	2,449
57 Northern Pacific.....	7,733.21	16,458,135	2,128	5,126
58 Spokane, Portland & Seattle.....	1,029.60	3,969,200	3,855	5,578
CENTRAL WESTERN REGION:				
59 Atchison, Topeka & Santa Fe.....	15,813.57	44,734,100	2,829	8,895
60 Chicago, Burlington & Quincy.....	9,792.81	20,411,022	2,084	5,760
61 Colorado & Southern.....	660.15	980,707	1,486	3,873
62 Fort Worth & Denver City.....	905.80	1,463,183	1,615	3,828
63 Denver & Rio Grande W. (Incl. D. & S. L.)..	2,674.14	5,430,327	2,031	6,058
64 Rock Island System.....	8,143.08	14,392,539	1,767	5,505
65 Northwestern Pacific.....	369.21	1,370,114	3,711	3,976
66 Southern Pacific.....	9,499.15	30,093,242	3,168	11,757
67 Union Pacific.....	11,526.41	40,103,160	3,479	10,523
68 Western Pacific.....	1,266.55	4,714,668	3,722	8,016
SOUTHWESTERN REGION:				
69 Frisco Lines.....	5,296.74	12,038,600	2,273	5,230
70 Kansas City Southern.....	986.56	1,770,964	1,795	9,887
71 Louisiana & Arkansas.....	704.45	1,577,498	2,239	4,500
72 Missouri-Kansas-Texas.....	3,357.48	6,086,200	1,813	5,081
73 Gulf Coast Lines.....	1,246.64	3,511,310	2,817	4,919
74 International-Great Northern.....	1,157.93	3,807,224	3,288	6,168
75 Missouri Pacific.....	7,564.43	18,346,485	2,425	5,852
76 Texas & Pacific.....	2,077.91	5,958,396	2,867	7,479
77 St. Louis Southwestern.....	1,554.80	5,181,950	3,333	7,872
78 Texas & New Orleans.....	4,631.25	12,283,537	2,652	6,088
Composite Average.....	255,996.70	700,668,902	2,737	7,898
AVERAGES BY REGIONS:				
New England.....	7,291.49	20,899,609	2,866	6,040
Great Lakes.....	30,747.18	93,812,805	3,051	11,176
Central Eastern.....	30,353.80	97,780,795	3,221	12,388
Poehontas.....	9,670.87	39,512,997	4,086	13,506
Southern.....	40,585.08	113,487,493	2,796	6,762
Northwestern.....	48,119.22	100,919,977	2,097	4,750
Central Western.....	60,650.87	163,693,062	2,699	8,285
Southwestern.....	28,578.19	70,562,164	2,469	5,981

a Based on a weight of 100 for first main track, 80 for additional main track, passing tracks, crossovers, and turnouts operated; mileage operated under trackage rights is excluded.

b Includes charges for maintenance of running tracks to Operating Expense Accounts 202, 208, 212, 214, 216, 218, 220, and total charges to Accounts 269, 270, 271, 272, and 274.

c Represents equivalent expense for one mile of first main track. Expense per mile of additional main track, passing tracks, crossovers, and turnouts may be computed as 80 per cent of this amount.

d Represents gross ton-miles (including locomotive and tender) freight and passenger service per mile of first main track.

Action Recommended
Acceptance as information,

OPERATING ADVANTAGES OF CENTRALIZED TRAFFIC CONTROL

Chapter III—Principles and Economics of Signaling, 1946 revision, contains tables consisting of summaries of published data referring to the economic phase of specific installations of various kinds of signaling. In connection with Table XVII—Advantages of Centralized Traffic Control, appearing on pp. 61-65 of Chapter III, the Committee reported on 14 additional installations at the 1947 Annual Meeting*, and herein submits information on an additional 31 installations:

Railroad	Location	In service	Miles of Road	Track	Trains per day	Pub. ref.
A. T. & S. F.	Belen to Vaughn, N. Mex.	1945	105.0	105.0	30	Ry. Sig., Feb. 1945, p. 167
	Freight train average speed increased 66 per cent westward and 100 per cent eastward.					
A. T. & S. F.	Waynoka, Okla. to Canadian, Tex.	1946	110.0	110.0	18-20	Ry. Sig., July 1947, p. 409
	Saved 4 hours per through freight train. Reduced break-in-twos.					
	Eliminated 1 helper truck.					
C. N.	Moncton, N. B. to Truro, N. S., Canada	1941	124.4	147.7	80	Ry. Sig., Sept. 1944, p. 483
	Handles 13.1 per cent increase in peak trains per day. Postponed and retired second track. Saved 120 minutes per freight train. Increased GTM/Train Hour 15 per cent. Increased speed from 13.8 to 18.1 miles per hour.					
C. N.	Truro to Halifax, N. S., Canada.	1944	47.5	49.6	48	Ry. Sig., Sept. 1944, p. 483
	Saved 90 minutes (1.91 minute per freight train mile) per freight train.					
C. & O. (PM)	Grandville (Grand Rapids), Mich., to Porter, Ind.	1948	130.7	142.0	20-30	Ry. Sig. & Comm., Apr. 1949, p. 243
	Increased track capacity. Saves considerable freight train time.					
	Eliminated 12 passing sidings. Saved \$40,000 bridge construction.					
	Increased train tonnage. Eliminated 15 main track switches.					

* A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 51-A and 334-A.

Railroad	Location	In service	Miles of Road	Track	Trains per day	Pub. ref.
C. & O.	Big Sandy Jct. to Martin, Ky. Increased capacity. Increased safety of train operation. Eliminated block stations.	1948	71.7	84.1	28	Ry. Age, Feb. 19, 1949, p. 41
C. & O.	Charlottesville to Orange, Va. Increased track capacity. Improved flexibility of operation.	1946	30.0	30.0	50	Ry. Sig., July 1946, p. 467
C. & E. I.	Clinton to Belt Yard (Evansville), Ind. Improved passenger train performance. Reduced operating expenses. Reduced average running time of through freight trains 1 hour and 40 minutes. Eliminated 8 passing sidings.	1947	122.0	122.0	40	Ry. Sig., May 1948, p. 281
C. & N. W.	West Chicago to Nelson, Ill. Advanced starting time of freight trains. Relieves congestion. Saved train time.	1950	75.0	150.0	54	Ry. Sig. & Comm., Apr. 1950, p. 217
C. B. & Q.	Aurora to Steward Jct., Ill. Saved 32 minutes per freight train.	1942	39.0	39.0	30	Ry. Sig., Apr. 1943, p. 198
C. B. & Q.	Flag Center to Savanna, Ill. Eliminated block offices. Saves train stops. Increases track capacity. Facilitates train movements.	1946	56.6	56.6	21-24	Ry. Sig., Aug. 1947, p. 489
C. B. & Q.	Lincoln to Brick Yard (Hastings), Nebr. Saves train stops. Expedites train movements.	1944	100.0	100.0	19	Ry. Sig., July 1945, p. 435
C. B. & Q.	Gaines (Hastings) to McCook, Nebr. Expedites train operation. Saves train stops. Eliminated block offices.	1946	131.0	131.0	23	Ry. Sig., Aug. 1946, p. 528
C. M. St. P. & P.	Glencoe, Minn. to Milbank, S. Dak. Reduced second track by 34.94 miles. Postponed additional second track. Improved operation. Eliminated considerable overtime. Reduced capital investment. Earned 14.1 per cent on investment.	1946	137.0	144.9	21	A.A.R. Sig. Sec. 1946 Proc., Vol. XLIV, p. 26-A

Railroad	Location	In service	Miles of Track		Trains per day	Pub. ref.
C. M. St. P. & P.	Aberdeen to Mobridge, S. Dak.	1946	98.0	98.0	14	A.A.R. Sig. Sec. 1949 Proc., Vol. XLVII, p. 15
	Reduced train stops, slow downs, and delays at meeting points. Saved 105 minutes per freight train or 1.07 minutes per freight train mile. Increased safety. Earned 22.6 per cent on investment.					
Clinchfield	Erwin, Tenn. to Delano, Va.	1949	122.0	122.0	30	Ry. Sig. & Comm., Feb. 1950, p. 92
	Discontinued 2 passing sidings. Saves considerable train time. Saves crew overtime. Eliminated 4 block offices and 5 operator tricks. Increases safety of train operation.					
D. & H.	Schenevus to Delanson, N. Y.	1940	22.5	48.9	50	Ry. Sig., Sept. 1941, p. 467
	23.67 miles of third track removed. Eliminated 3 mechanical interlockings.					
D. & R. G. W.	Dotsero, Colo. to Helper, Utah	1944	284.0	284.0	35-44	Ry. Sig., Nov. 1944, p. 614
	Increased capacity. Speeded up freight and passenger movements.					
	Improved utilization of power. Eliminated block stations.					
D. & S. L.	Denver to Orestod, Colo.	1945	127.2	131.9	30-38	Ry. Sig., Mar. 1946, p. 194
	Increased track capacity. Saves freight train hours. Increased average speed. Increased availability of motive power. Decreased train stops. Improved passenger train performance. Eliminated 15 main line switches. Increased safety.					
G. M. & O.	Murphysboro to Davis, Ill.	1948	58.0	58.0	14	Ry. Sig., June 1948, p. 348
	Eliminated helpers on grades.					
K. C. S.	DeQuincy, La. to Beaumont, Tex.	1944	46.0	46.0	35-45	Ry. Sig., Mar. 1945, p. 153
	Increased safety of train operation. Eliminated block offices. Expedited train movements. Saved train stops.					
L. & N.	Ravenna to Blackey, Ky.	1949	124.0	142.0	24	Ry. Sig. & Comm., Mar. 1950, p. 163
	3 miles of second main track converted to siding. 14 block offices closed. Saves 240 minutes per northward (loaded) freight train. Reduced stops for coal and water. Increased safety of train operation.					

Railroad	Location	In service	Miles of Road	Track	Trains per day	Pub. ref.
L. & N.	Henderson to Strawberry, Ky. Saved 1 to 2 hours per freight train. Eliminated 25 passing sidings. Saved train stops. Eliminated block offices.	1947	137.5	137.5	16	Ry. Sig., Dec. 1947, p. 782
M. P.	Knobel to Diaz, Ark. Increased average speed southward 40 per cent; northward 14 per cent. Increased tonnage per train southward 31 per cent; northward 13 per cent. Earned 68 per cent on investment.	1943	60.7	60.7	41	A.A.R. Sig. Sec. 1945 Proc., Vol. XLIII, p. 15
P. R. R.	Tyrone to Lock Haven, Pa. Eliminated 2 sidings. Either direction on 5 mile, 2 main track section. Saved 36 minutes eastward; 59 minutes westward per freight train. Saved train stops. Increased speed 2.8 miles per hour eastward; 4 miles per hour westward. Increased capacity. Earned 18.7 per cent on investment.	1946	52.7	57.7	30	Ry. Sig., Jan. 1947, p. 31 and A.A.R. Sig. Sec. 1948 Proc., Vol. XLVI, p. 7
St. L.-S. F.	Afton to East Tulsa, Okla. Eliminated 9 sidings. Saved 60 or more minutes per freight train. Saves train stops. Increased train tonnage. Saves terminal delay. Eliminated yard limits.	1947	75.0	75.0	35	Ry. Sig. & Comm., June 1949, p. 367
St. L.-S. F.	Edward, Kans. to Afton, Okla. Increased safety of train operation. Eliminated 10 passing sidings completely and 7 more as passing sidings.	1949	84.0	84.0	12	Ry. Age, Sept. 30, 1950, p. 541
S. P.	Colton to Indio, Calif. Increased track capacity on heavy grade. Saves an average of 85 minutes per train.	1943	70.8	70.8	34	Ry. Sig., Feb. 1945, p. 94
U. P.	Las Vegas to Caliente, Nev. Increased 4.7 cars and 210 tons per freight train. Saved 102 minutes per freight train. Saved 40 minutes terminal time. Saved 34 minutes over time. Saved 6 locomotives. Saved 32,850 car days per year. Saved 88,330 train stops. Saved 171,575 man hours. Saved 174 minutes per helper.	1945	125.3	125.3	35	A.A.R. Sig. Sec. 1947 Proc., Vol. XLV, p. 57

Railroad	Location	In service	Road	Miles of Track	Trains per day	Pub. ref.
Virginian	Mullens to Deepwater, W. Va. Reduced time for tonnage freight trains.	1942	57.8	57.8	30	Ry. Age, Jan. 23, 1943, p. 249
Wabash	Montpelier, Ohio to New Haven, Ind. Saves 20 to 30 minutes per freight train on road, and considerable time enter- ing and leaving yard at Montpelier.	1949	43.0	44.0	18	Ry. Sig. & Comm., Oct. 1950, p. 629

Action Recommended
Acceptance as information.

OPERATING ADVANTAGES OF INTERLOCKING INSTALLATION
AT FOSTORIA, OHIO, ON THE NEW YORK CENTRAL R.R.*

On June 27, 1949, the New York Central R.R., in collaboration with the Baltimore & Ohio R.R., New York, Chicago & St. Louis R.R., and Chesapeake & Ohio Ry., placed in service an NX interlocking at Fostoria, Ohio, involving an extensive network of tracks that crisscross at that point.

Formerly, trains on all roads were required to make two stops in each direction. Tilting crossbar signals and statutory Stop boards were in service, and signalmen were on duty 24 hours daily at 5 points, one of which was a mechanical plant.

The daily traffic consists of:

Passenger trains	Freight trains	Total trains
6 N. Y. C.	17 N. Y. C.	23 N. Y. C.
14 B. & O.	35 B. & O.	49 B. & O.
6 N. Y. C. & St. L.	19 N. Y. C. & St. L.	25 N. Y. C. & St. L.
4 C. & O.	32 C. & O.	36 C. & O.
30 Total	103 Total	133 Total

In addition to the 133 through train movements, there is an average of 180 switching movements over these crossings, making an average of 313 movements daily. The switching is done by 10 crews, 6 of which are on the same shift.

The elimination of two stops per through train amounts to 97,090 stops annually. Allowing for stops that are being made account train on conflicting line using crossing, it is conservatively estimated a reduction of 91,250 stops is being made annually, with a saving in time of 15 to 30 minutes per through train.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$977,000
(b) Operating Expenses.....	35,000
(c) Total.....	<u>\$1,012,000</u>
2. Gross Saving per Annum.....	\$ 514,319
3. Increased Annual Operating Expenses.....	52,528
4. Net Reduction in Annual Operating Expenses.....	<u>\$ 461,791</u>
5. Deduction for Interest Charges @ 5% (of 1-a).....	48,850
6. Net Saving per Annum.....	<u>\$ 412,941</u>
7. Annual Return over 5% Interest:	
(a) On Capital Investment (6 ÷ 1-a).....	42.3%
(b) On Total Cost (6 ÷ 1-c).....	40.8%

* *Railway Signaling and Communications*, July 1950, p. 411.
Railway Age, September 16, 1950, p. 46.

Summary

The interlocking installation, through the elimination of triangle tie-ups, the reduction of crossing stops by 91,250, the retirement of signal offices, the speeding up of freight train movements by 9,400 hours, and the reduction of pulled draw bars, is estimated to be saving \$412,941 annually, with a return on the capital investment of 42.3 per cent, or sufficient to pay for the installation in $2\frac{1}{3}$ years.

In addition, the safety of train operation has been increased.

Furthermore, the highway crossing protection at 14 highway crossings included in the installation has increased the safety protection for vehicular traffic.

Action Recommended

Acceptance as information.

COMMITTEE II—INTERLOCKING

Personnel

H. A. Hudson, Chairman

R. W. Troth, Vice-Chairman

R. B. Amsden	C. B. Mason
G. B. Blatt	H. A. Maynard
C. F. Brooks	H. L. Moseley
J. J. Clancy	K. L. Muse
L. Cone	W. G. Salmonson
C. M. Duffy	L. E. Scoles
W. A. Ford	V. P. Shepardson
D. W. Fuller	C. M. Wallace
C. F. Grundy	J. F. Yerger
E. K. Horns	F. J. Ackerman*

J. P. Hopton*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Collaborate with A.R.E.A. Committee 5 on switch, frog and crossing layout plans, in order to make layouts as universal as possible for the application of signals and interlocking, including location of insulated rail joints in turnouts, crossovers and crossings.
4. Investigate and prepare recommendations to A.R.E.A. Committee 5 for inclusion of application of roller bearings to interlocked and spring switch layout plans, collaborating in accordance with Assignment 3.

The Committee submits for consideration, reports on the following subjects**:

1. Specification 258-51.
 Revision of Specification 149-43, Manual Part 97.
 Revision of Specification 67-43, Manual Part 79.
 Revision of Specification 65-42, Manual Part 75.
 Revision of Specification 141-43, Manual Part 208.
 Revision of Specification 203-44, Manual Part 209.
 Revision of Specification 66-41, Manual Part 76.
 Revision of Specification 152-50, Manual Part 30.
 Revision of Requisites for Movable Bridge Interlocking, Manual Part 64.
 Revision of Specification 76-49, Manual Part 85.
 Revision of Specification 75-46, Manual Part 82.
 Removal of Specification 114-46 from Manual Part 83.
 Revision of Requisites for Mechanically Locking the Levers of Interlocking Machines, Manual Part 99.
 Revision of Specification 198-46, Manual Part 109.
 Revision of Specification 150-43, Manual Part 98.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

Revision of Specification 101-50, Manual Part 104.

Revision of Specification 138-44, Manual Part 197.

3. Plans for switches, frogs, crossings, spring and slip switches, collaborating with A.R.E.A. Committee 5—Track.

4. Application of roller bearings to A.R.E.A. interlocked and spring switch layout plans.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.I.E.E.—American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

A.R.E.A.—American Railway Engineering Association, 59 E. Van Buren St., Chicago 5, Ill.

A.S.M.E.—American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

Disposition of 1950 Letter Ballot Subjects

The following subjects presented by Committee II at the 1950 Annual Meeting were submitted to letter ballot and officially approved:

Specification 152-50—Electro-Pneumatic Switch Operating Mechanism—Now in Manual Part 30.

Specification 101-50—Electric Motor Switch Operating Mechanism—Now in Manual Part 104.

A.A.R. Sig. Sec. 1457C—Load Requirement for Power-Operated Switch Mechanism—Now in Drawing Section of Manual.

A.A.R. SIGNAL SECTION SPECIFICATION 258-51.

INTERLOCKING

1. *Purpose.*

(a) This specification is for the purpose of providing for the installation of interlocking. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing installations when general renewal or replacement becomes desirable.

(b) Further specific details peculiar to a particular type of interlocking, when required, are covered by:

1. Specification for Electric Interlocking, Manual Part 75.
2. Specification for Electro-Mechanical and Mechanical Interlocking, Manual Part 76.
3. Specification for Electro-Pneumatic Interlocking, Manual Part 79.
4. Specification for Automatic Interlocking, Manual Part 208.
5. Specification for All-Relay Interlocking, Manual Part 209.

*General Provisions*2. *Details of work.*

(a) Details of work include the following:

1. Buildings.
2. Power supply:
 - (a) Electric.
 - (b) Pneumatic.
3. Distributing system:
 - (a) Aerial.
 - (b) Surface.
 - (c) Underground.
 - (d) Submarine.
 - (e) Main air pipe line.
4. Control apparatus.
5. Interlocking machine.
6. Control machine.
7. Foundations.
8. Switch operating mechanism and fittings.
9. Switch-and-lock movement and fittings.
10. Signals.
11. Communication system.
12. Wires and cables.
13. Trunking, conduit and supports.
14. Instrument and battery housings.
15. Insulation.
16. Rail bonding.
17. Painting.
18.
19.

Note.—The recommended forms of construction contract, proposal, and bond, will be found in the Manual of the American Railway Engineering Assn., under the heading "Uniform General Contract Forms."

3. Requisites, specifications, drawings, instructions and standards.

(a) Requisites, specifications, drawings, instructions and standards referred to in the body of this specification form an essential part hereof.

(b) Purchaser's drawings should include the following:

1. Track and signal plan or map drawn to scale with information as to grades and alignment; interlocking stations; existing and proposed signals designating type, signal numbers; location and capacity of existing junction boxes, relay and battery housings; location and size of main air line; existing and proposed switches, derails and movable point frogs, designating their normal position and whether interlocked; power stations or source; steam and electric railway and highway crossings, including undergrade and overgrade; highway crossing protection; pole line or other supports for line wires or aerial cables; number of poles per mile; average distance of pole line from track; location, number, kind or type, and size of underground cable, conduits, ducts, manholes, and junction or terminal boxes; weight and section of rail; kind and condition of ballast and such other physical characteristics or information as is desirable. Drawing, dated

2. Circuit plans for existing installations in the territory to be signaled. Drawing, dated

3. Plans showing location and capacity of existing junction boxes, relay and battery housings. Drawing, dated

4. Plans showing typical circuits for the control of power-operated switches and signals; switch indicators; protection for facing and trailing point switches; main line and siding crossovers; highway crossing signals; train order signals and other devices. Drawing, dated

5. Detail drawing of interlocking station building. Drawing, dated

6. Such standards and other drawings as the Purchaser desires to furnish. Drawing, dated

(c) After contract is awarded, Purchaser shall furnish the Contractor, as required, prints of Purchaser's approved drawings that form an essential part of this specification.

(d) Framed track diagram shall be furnished in place by Purchaser in interlocking station. *R-3-d.

(e) Manipulation chart shall be furnished in place by Purchaser in interlocking station. *R-3-e.

(f) Contractor's drawings.

1. Contractor shall furnish with his proposal, drawings or references for the apparatus he proposes to furnish, which are not covered by the drawings furnished by the Purchaser.

* Alternate requisites section.

3. *Requisites, specifications, drawings, instructions and standards.*— Continued.

2. Within days after receipt of the drawings, the Purchaser will indicate any corrections that may be necessary, or signify his approval.

3. Contractor shall be responsible for the correctness of all drawings furnished by him, although the drawings may have been approved by the Purchaser.

4. Any work done by the Contractor prior to the approval of the Contractor's drawings will be done at the Contractor's risk, unless previously authorized in writing by accredited representative of the Purchaser.

5. No change shall be made in any approved drawing without the written consent of the Purchaser.

6. After completion of contract, the Contractor shall designate on station map the location of underground cables, main air lines, air strainers, auxiliary reservoirs, valves, alcohol feeders, branch connections and expansion joints, and shall furnish the Purchaser corrected tracings of drawings furnished by him in accordance with section 3-g.

(g) After award of the contract and before work is begun, the Contractor shall furnish for the approval of the Purchaser, the following drawings as scheduled by the Purchaser (*R-3-g):

1. Track plan showing switches, signals, relays, transformers, and batteries and their locations, within days.

2. Detail circuit plans, within days.

3. Instrument case wiring plans, within days.

4. Cable diagrams, within days.

5. Pole line diagrams, within days.

6. Contractor shall furnish the Purchaser, as required, prints of Contractor's approved drawings that form an essential part hereof.

7.

8.

4. *Furnished by the Purchaser.*

(a) Purchaser will obtain necessary permits from Federal, State and Municipal authorities.

(b) Purchaser will furnish, as indicated in sections 4-c, d and e, material or labor, or both, on the following items:

1. Ties for support of apparatus.

2. Move ties as may be necessary.

3. Switches, derails and movable point frogs of the required throw.

4. Move switch and tie rods as may be necessary.

5. Track bonding.

6. Insulated rail joints.

* Alternate requisites section.

4. *Furnished by the Purchaser.*—Continued.

7. Bridge insulations.
8. Switch-rod insulations.
9. Tie-rod insulations.
10. Gage-plate insulations.
11. Gage, switch and butt plates.
12. Rail braces.
13. Concrete material:
 - (a) Cement.
 - (b) Sand.
 - (c) Stone.
 - (d) Water.
14. Precast foundations.
15. Necessary grading and drainage.
16. Excavation of rock.
17. Poles, guy wires, anchors and bracing for aerial lines.
18. Cross-arms, pins, insulators and fittings.
19. Line wire.
20. Battery housings.
21. Signal bridges.
22. Cables:
 - (a) Aerial.
 - (b) Submarine.
 - (c)
 - (d)
23. Conduit:
 - (a) Main.
 - (b) Branch.
 - (c)
 - (d)
24. Manholes.
25. Sand, clay or loam for cable trench, including protection plank.
26. Apply necessary attachments to signal apparatus in service.
27. Make necessary alterations of any part of existing structures or apparatus.
28. Unload and properly house material that arrives on the ground before the Contractor's force; this work to be done under the supervision of the Contractor's representative.
29. Distribute material.
30. Buildings.
31. Tools, fixtures for building and supplies required for the maintenance of the system.
32. Automatic time recorder.
33. Submarine air pipe line.
34. Prior to installation, furnish stakes establishing grade of track at points where required.
35. Communication system.

4. *Furnished by the Purchaser.*—Continued.

36. Number plates.

37. Remove existing cross-bonding where necessary (electric roads).

38.

39.

(c) Material only on items

(d) Labor only on items

(e) Material and labor on items

(f) Purchaser will furnish the items as indicated in sections 4-c, d and e, subject to inspection of the Contractor, who shall state any objections thereto before starting his part of the work. After rectification by the Purchaser of any defects reported, the Contractor shall assume full responsibility for the proper functioning of the installation. The intent of this section is to bar any claim by the Contractor that the work done by the Purchaser has not been performed in such manner as to enable him to fulfill all the provisions of the contract.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

(b) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed.

6. *Shipment of material.*

(a) Material shall be shipped to, care of, marked for Material shipped from Contractor's factory at shall be shipped via and thence via to destination.

7. *Transportation.*

(a) Purchaser will furnish transportation for men, necessary for the installation, over the following lines (*R-7-a):

1.

2.

(b) Purchaser will furnish transportation for tools and material, necessary for the installation, over the following lines (*R-7-b):

1.

2.

* Alternate requisites section.

7. *Transportation.*—Continued.

(c) Purchaser will furnish work train service for distribution of material. *R-7-c.

(d) Purchaser will furnish work train service for erection of apparatus. *R-7-d.

8. *Inspection of installation.*

(a) Contractor shall advise the Purchaser days in advance of the time installation will be completed and ready for final inspection. Purchaser will make inspection and tests within days after completion of the work.

9. *Tests.*

(a) Contractor shall make such tests as may be necessary to demonstrate, to the satisfaction of the Purchaser, that the apparatus, as installed, is in accordance with the requirements of the specifications and contract. These tests, unless otherwise specified, shall include the tests shown in section 9-b and shall be conducted in accordance with A.A.R. Signal Section instructions for testing, when available, otherwise as directed by the Purchaser. Contractor shall provide such instruments and apparatus as may be necessary for making tests. Instruments and apparatus shall remain the property of the Contractor.

(b) The following tests shall be made:

1. General.

(a) Service test to determine that signals and interlocking function as intended.

(b) Service test to determine that control system functions as intended.

(c) Tests to determine that all circuits conform to approved circuit plans by individually electrically checking each contact selection.

(d) Test of all electrically operated devices to determine that electrical operating characteristics are in accordance with specifications.

2. Insulation.

(a) Test of insulation resistance of each complete circuit, in accordance with Purchaser's instructions, shall be made when wires, cables, and insulation involved are dry.

(b) Switch-rod insulation shall be tested in accordance with Specification 216, Manual Part 116.

3. Switch apparatus.

(a) Test to determine that switch circuit controller connected at the point to switch, derail, or movable point frog, is so adjusted that its contacts will not be in position corresponding to switch point closure when switch point is open $\frac{1}{4}$ in. or more.

* Alternate requisites section.

9. *Tests.*—Continued.

(b) Test to determine that plunger of facing point lock has at least 8 in. stroke when operated by lever, and that plunger shall pass through lock rod $\frac{1}{2}$ in. or more when lever is in locked position.

(c) Test to determine that bolt lock prevents signal governing movements over switch or derail, and displaying an aspect indicating Stop, from being operated to display a less restrictive aspect while derail is in derailling position, or when switch point is open $\frac{1}{2}$ in. or more.

(d) Test to determine that switch, movable point frog, or split point derail cannot be locked if the switch point is prevented by an obstruction from closing to within $\frac{1}{4}$ in.

(e) Test to determine that point detector controller contacts will not assume the position corresponding to switch point closure if the switch point is prevented by an obstruction from closing $\frac{1}{4}$ in.

(f) Test of switch indicating circuits to determine that switches do not indicate before mechanism has locked in position corresponding with lever, and that proceed aspects of signals cannot be displayed unless the switch and its controlling lever, or equivalent device, are in corresponding position.

(g) Test of electro-pneumatic switch operating mechanism to determine that friction lock is in correct adjustment and functions properly.

(h) Test of electro-pneumatic switch operating mechanism to determine the integrity of restoring feature and circuits.

(i) Test of electro-pneumatic switch operating mechanism to determine that it is in accordance with Specification 152, Manual Part 30.

(j) Test to determine that air distribution is such that leakage in any section of the air line system will not exceed 1 lb. in 1 minute from the normal pressure, with all apparatus connected and at rest.

(k) Test of electric motor switch operating mechanism to determine that clutch is properly adjusted.

(l) Test of electric motor switch operating mechanism to determine that it is in accordance with Specification 101, Manual Part 104.

(m) Test of electro-pneumatic and electric motor switch operating mechanisms for single switches, movable point frogs, and derails, to determine proper operation at prescribed minimum air pressure, or operating voltage.

9. *Tests.*—Continued.

4. Interlocking machine.

(a) Test of spring combination to determine that adjustments conform to approved plan.

(b) Test of mechanical locking to determine that it is in accordance with Requisites for Mechanically Locking the Levers of Interlocking Machines, Manual Part 99.

(c) Test of electric lever locks, time locks, circuit controllers and lever lights to determine that these devices conform to approved plans and are in accordance with the following:

1. Electric Interlocking Machine—Specification 76, Manual Part 85.

2. Electro-Mechanical Interlocking Machine—Specification 134, Manual Part 193.

3. Mechanical Interlocking Machine, S. & F. Locking—Specification 75, Manual Part 82.

5. Control machine.

(a) Test of controller contacts to determine that adjustments conform to approved plan.

(b) Test of circuit controllers and indication lights to determine that these devices conform to approved plans and are in accordance with the following:

1. Centralized Traffic Control Machines—Specification 150, Manual Part 98.

2. All-Relay Interlocking Control Machine—Specification 208, Manual Part 210.

6. Switch circuit controllers.

(a) Test to determine that switch circuit controllers are in accordance with Instructions for Switch Circuit Controllers, Manual Part 134.

7. Track circuits.

(a) Test to determine that track circuits have been installed in accordance with approved plans and adjusted in accordance with Instructions for Track Circuits, Manual Parts 8, 162 and 218.

8. Voltage.

(a) Test to determine that voltage for all apparatus is in accordance with Manufacturer's specifications and that voltage applied to lamps is in accordance with specifications furnished by the Purchaser.

9. Signals.

(a) Test to determine that light and semaphore signals are in accordance with Instructions for Light and Semaphore Signals, Manual Part 54.

10. *Placing in service.*

(a) After receipt of written authority from the Purchaser, the Contractor shall place the installation in service under supervision of the Purchaser, and shall leave competent men on duty for days thereafter. *R-10-a.

(b) Signal aspects shall be displayed or changed only as authorized by the Purchaser.

11. *Completion.*

(a) When installation is completed, apparatus and surface of the ground which has been affected by the installation, shall be left in a neat and clean condition and all temporary structures removed.

12. *Clearances.*

(a) Clearances shall conform to clearance diagram recommended by the A.A.R. *R-12-a.

*Detail Provisions*13. *Power supply.*

(a) Purchaser will furnish volts a.c., cycles, phase at points as shown on Drawing , dated

14. *Power plant.*

(a) Power plant shall consist of

(b) shall be furnished by and installed by

(c) shall be furnished by and installed by

15. *Power house.*

(a) Building shall be provided by, in accordance with Specification, dated, and Drawing, dated

16. *Auxiliary power plant.*

(a) Auxiliary power plant when required shall consist of

(b) shall be furnished by and installed by

(c) shall be furnished by and installed by

* Alternate requisites section.

17. *Switchboards and equipment.*

(a) Switchboards and equipment shall be in accordance with Specification 107, Manual Part 153. *R-17-a.

18. *Switchboard circuits.*

(a) Contractor's recommended arrangement of circuits shall be followed, subject to modifications to meet Purchaser's special requirements.

19. *Generator.*

(a) Alternating current generator shall be of kv-a. capacity at frequency, volts, phase and shall be in accordance with A.I.E.E. Standards.

(b) Direct current generator shall be of k.w. capacity at volts and shall be in accordance with A.I.E.E. Standards.

20. *Motor.*

(a) Motor shall be h.p. capacity at frequency, volts, phase a.c.; or volts d.c., and shall be in accordance with A.I.E.E. Standards.

21. *Motor-generator.*

(a) Motor-generator shall be direct-connected, mounted on a cast-iron or arc-welded steel fabricated sub-base. *R-21-a.

22. *Air compressors, governors and strainers.*

(a) Air compressors, $\left\{ \begin{array}{l} \text{one-stage} \\ \text{compound} \end{array} \right\}$, with a capacity of cu. ft. piston displacement free air per minute, and designed for air pressure of lbs., manufactured by, shall be furnished and installed by Contractor. *R-22-a.

(b) Foundation shall be furnished and installed by Contractor, and constructed in accordance with the specifications which shall be attached to the Contractor's bid. *R-22-b.

(c) Automatic governors shall be provided by and shall be arranged to cut in the compressor at lbs., and cut out at lbs. pressure. *R-22-c.

(d) An air strainer, approved by the Purchaser, shall be installed in each air intake pipe.

(e) When air compressors are furnished in duplicate, interchange control panels shall be furnished for operating each compressor from either of the governors. *R-22-e.

(f) Air compressors shall be direct-connected and motor-driven and shall be mounted on a cast-iron base. Motor shall be in accordance with A.I.E.E. Standards. *R-22-f.

* Alternate requisites section.

23. *Air reservoirs.*

(a) An auxiliary air reservoir for collection of condensation shall be furnished and installed for each condenser or section thereof, for each low spot in the main air pipe and at such other locations as shall be designated by the Purchaser. Each reservoir shall be equipped with stop cock and blow-off pipe extending from bottom of reservoir.

(b) Extra large reservoirs called expansion tanks shall be used to provide a stand-by air supply. These reservoirs shall be properly equipped for drainage. *R-23-b.

(c) All steel reservoirs shall be designed for 150 lbs. per sq. in. working pressure and manufactured and tested in accordance with A.S.M.E. Code for Unfired Pressure Vessels. Cast-iron reservoirs shall be tested to a hydrostatic pressure of 300 lbs. per sq. in.

24. *Air pipe lines.*

(a) Air lines shall be best quality galvanized extra heavy wrought iron pipe for underground service, and galvanized copper-bearing extra heavy steel pipe for service above ground, free from zinc oxide or other foreign matter that may scale off. *R-24-a.

1. Main air lines shall be not less than 2 inches in diameter. *R-24-a-1.

2. Branches to switches shall be not less than $\frac{3}{4}$ inch in diameter. *R-24-a-2.

3. Branches to signals shall be not less than $\frac{1}{2}$ inch in diameter. *R-24-a-3.

(b) Pipe 2 inches in diameter and larger shall be lapweld; pipe of lesser diameter may be butt weld.

(c) Each length of pipe larger than $\frac{3}{4}$ in. diameter shall be provided with two metallic thread protectors and one extra heavy galvanized recessed coupling shipped separately in boxes. Pipes of $\frac{3}{4}$ inch diameter and smaller may be shipped in bundles with one end protected with heavy burlap and the extra heavy galvanized recessed coupling turned on the pipe hand tight.

(d) Expansion joints for pipes 2 inches in diameter or larger shall have an iron body, a brass or iron sleeve and allowance for 6 in. expansion. *R-24-d.

(e) Gate or globe valve shall have brass seat, rising stem, ends for in. pipe and designed for a working air pressure up to 150 lbs. per sq. in. *R-24-e.

(f) Stop cocks, screw unions, combination stop cocks and screw unions for $\frac{3}{4}$ in. pipe or smaller shall be provided with brass seats and designed for a working air pressure up to 150 lbs. per sq. in. *R-24-f.

* Alternate requisites section.

24. *Air pipe lines.*—Continued.

(g) Flexible connections shall be best quality $\frac{1}{2}$ in. armored hose having 3 in. nipple inserted and securely fastened in each end and having not less than 16 in. of hose between the ends of the nipples. Complete connection shall be capable of withstanding a working pressure of 150 lbs. per sq. in.

(h) All iron pipe fittings including tees, elbows, street ells, and reducers, shall be A.A.R. Mechanical Division 300 lb. extra heavy malleable iron or steel, galvanized. Galvanizing shall be in accordance with Specifications for Metallic Coating of Metals, Manual Part 63.

(i) Pipe unions between 1 and $1\frac{3}{4}$ in. diameter, inclusive, shall be A.A.R. Mechanical Division 300 lb. extra heavy malleable iron or steel, screw type with ground joint and brass to iron seat, galvanized. Flange unions where used shall be of forged steel, galvanized. Galvanizing shall be in accordance with Specifications for Metallic Coating of Metals, Manual Part 63.

(j) Branch air line shall be taken from the top of the main air line, the connection being made by means of two street or service ells so arranged as to form a hinged joint to provide for expansion.

(k) Expansion joints shall be placed in the main air line not more than 500 ft. apart where pipe is located above ground and 1,500 ft. where pipe is located underground. *R-24-k.

(l) Main air line, when above ground, shall be securely anchored midway between each pair of expansion joints and at ends of line.

(m) Each branch line must contain a brass combined cock and union at or near its connection with the main.

(n) Check valves shall be installed in main air line as designated by Purchaser.

(o) Approved type of air filter shall be installed between each branch line and pneumatically operated unit. *R-24-o.

(p) Provisions shall be made for draining condensation out of air distribution system at low points.

(q) Main air line must be in good surface and so graded that condensation will run into suitable drain tanks. Main reservoirs shall be connected in series with the main air line and be provided with by-pass of the same size as the main air line. Flanges, unions, gate valves, etc., shall be provided so that main reservoirs may be removed without interrupting the flow of air through the by-pass.

(r) Pipe line installed in clean gravel or stone ballast shall have no special protection provided. Pipe line installed in cinder ballast shall be surrounded by 4 in. of sand, loam or clay.

*Alternate requisites section.

24. *Air pipe lines.*—Continued.

(s) Air line when placed above the ground parallel to the track shall not be placed nearer than 6 ft. from the gage side of the rail, except by permission of the Purchaser.

(t) Local conditions shall determine the height of the main air line when above ground but in all cases the bottom of the pipe shall be not less than 6 in. above the top of the ground, except by permission of the Purchaser.

(u) Supports for main air line shall be placed not more than 10 ft. apart.

(v) Red lead, graphite or equivalent must be applied to the pipe threads and only after pipe connections have been started when pipe is coupled.

(w) Each length of pipe and the fittings must be free from dirt and scale before being coupled in the line, and care must be exercised that no dirt gets in the line at any time. Pipe lines must be blown out before being connected to any apparatus.

(x) Galvanizing shall be in accordance with Specifications for Metallic Coating of Metals, Manual Part 63.

25. *Compressed air condensers.*

(a) Condensers shall be of the atmospheric type. *R-25-a.

(b) Condensers shall be located as close to the compressor as practicable. They shall have a radiating surface of 1 sq. ft. per cu. ft. capacity of compressor. Condensers shall be in accordance with specifications and shall be furnished by the and installed by the

26. *Transformers.*

(a) Oil-cooled transformer shall be in accordance with Specification 84, Manual Part 165.

(b) Air-cooled transformer shall be in accordance with Specification 83, Manual Part 164.

(c)

27. *Rectifiers.*

(a) Rectifiers shall be of type.

(b) Rectifiers shall be in accordance with the following specifications, where applicable:

1. Copper-Oxide Rectifiers and Valves—Specification 166, Manual Part 139.

2. Tantalum Rectifiers and Valves—Specification 189, Manual Part 47.

3. Selenium Rectifiers—Specification 229, Manual Part 243.

* Alternate requisites section.

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27. Rectifiers.—Continued.

- (c) Track circuit rectifier characteristics.
 - 1. A.C. volts , cycles
 - 2. D.C. volts maximum..... , minimum ,
amperes maximum , minimum , for:
 - (a) Operating track circuits direct.
 - (b) Charging cells, type
storage battery.
 - (c) Use in multiple with cells, type
primary battery.
- (d) Line circuit rectifier characteristics.
 - 1. A.C. volts , cycles
 - 2. D.C. volts maximum , minimum ,
amperes maximum , minimum , for:
 - (a) Operating line circuits direct.
 - (b) Charging cells, type
storage battery.
 - (c) Use in multiple with cells, type
primary battery.
- (e) Signal operating rectifier characteristics.
 - 1. A.C. volts , cycles
 - 2. D.C. volts maximum , minimum ,
amperes maximum , minimum , for:
 - (a) Operating signals direct.
 - (b) Charging cells, type
storage battery.
 - (c) Use in multiple with cells, type
primary battery.
- (f) rectifier characteristics.
 - 1. A.C. volts , cycles
 - 2. D.C. volts maximum , minimum ,
amperes maximum , minimum , for:
 - (a)
 - (b) Charging cells, type
storage battery.
 - (c) Use in multiple with cells, type
primary battery.

28. Batteries.

- (a) Batteries shall be in accordance with the following specifications and drawings:
 - 1. Nickel, Iron, Alkaline Storage Battery—Specification 49, Manual Part 15.
 - 2. Lead Acid Stationary Storage Battery (Plates of Pure Lead)—Specification 58, Manual Part 19.
 - 3. Lead Type Portable Storage Battery for Signaling—Specification , dated
 - 4. Lead Acid Stationary Storage Battery (Plates of Alloy Composition)—Specification 158, Manual Part 117.

28. *Batteries.*—Continued.

5. Lead Acid Stationary Storage Battery (Plates of Composite Structure)—Specification 53, Manual Part 18.

6. Specification for Electrolyte, Manual Part 13.

7. Type "A" Copper-Oxide Caustic Soda Primary Cell—Specification 87, Manual Part 6.

8. Type "B" Copper-Oxide Caustic Soda Primary Cell—Specification 171, Manual Part 4.

9. Air Depolarized Carbon Caustic Soda Primary Cell—Specification 172, Manual Part 16.

10. Battery Jar (Primary)—Specification 113, Manual Part 9.

11. Battery Jar (Storage)—Specification, dated

12. Round Jars and Cover—Drawing 1053.

13. Rectangular Jars and Cover—Drawing 1418 or 1419.

14. Porcelain Covers (Air Depolarized Primary Battery)—Drawing 1417.

(b) Jars for caustic soda type of battery shall conform to Drawing, dated

(c) Main operating batteries shall consist of sets
..... cells of type ampere-hour capacity.

(d) Local operating batteries shall consist of:

1. sets cells of type
..... ampere-hour capacity.

2. sets cells of type
..... ampere-hour capacity.

(e) Track batteries shall be of cells of type ampere-hour capacity.

(f) Line batteries shall be of cells of type ampere-hour capacity.

(g) Supports for batteries in interlocking station shall be furnished in place by the and shall conform to Drawing, dated

(h) The initial charge of storage battery shall be conducted by the Current at the proper voltage for initial charge shall be provided by

(i) The shall furnish with each set of main battery, one hydrometer and one battery thermometer.

(j) Installation of various types of batteries shall be in accordance with the following:

1. Instructions for Copper-Oxide Caustic Soda Primary Cells, Manual Part 7.

2. Instructions for Storage Batteries, Manual Part 14.

29. *Interlocking or control station.*

(a) Building shall be provided by, in accordance with Specification, dated, and Drawing, dated

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30. *Interlocking machine.*

(a) Interlocking machine shall be in accordance with the following:

1. Electric Interlocking Machine—Specification 76, Manual Part 85.
2. Electro-Mechanical Interlocking Machine—Specification 134, Manual Part 193.
3. Mechanical Interlocking Machine, S. & F. Locking—Specification 75, Manual Part 82.
4. Electro-Pneumatic Interlocking Machine.—See Electric Interlocking Machine, Specification 76, Manual Part 85.

31. *Control machine.*

(a) Control machine shall be in accordance with the following:

1. Centralized Traffic Control Machine—Specification 150, Manual Part 98.
2. All-Relay Interlocking Control Machine—Specification 208, Manual Part 210.

32. *Building lighting.*

(a) Lighting shall be in accordance with Specification, dated, and Drawing, dated

(b) Wiring, fixtures, accessories and installation for electric lighting shall be in accordance with rules of the National Board of Fire Underwriters and requirements of local authorities.

33. *Lightning arresters.*

(a) Line arresters, type, shall meet A.I.E.E. requirements and shall be installed as shown on circuit drawings.

(b) Low-voltage arresters, type, shall meet the requirements of Specification 52, Manual Part 95, and shall be installed as shown on circuit drawings.

(c) Arrester grounds shall be in accordance with Specification 60, Manual Part 92. Contractor's liability is limited to ground rods per location.

(d) Arresters for code lines shall be particularly sensitive and provide insulation resistance equivalent to an open space or air gap arrester.

(e) Arresters of design shall be installed as shown on circuit drawings.

34. *Wires and cables.*

(a) Wires and cables shall be in accordance with the following specifications:

1. Copper-Bearing Steel Wire with or without Weather-Resistant Covering—Specification 196, Manual Part 181.
2. Copper-Covered Steel Wire with or without Weather-Resistant Coverings—Specification 167, Manual Part 180.

34. *Wires and cables.*—Continued.

3. Copper Alloy Wire with or without Weather-Resistant Covering—Specification 168, Manual Part 173.

4. Hard-Drawn Copper Wire with or without Weather-Resistant Covering—Specification 169, Manual Part 182.

5. Specification for Galvanized Steel Strand, Manual Part 184.

6. Specification for Bronze Guy and Messenger Strand, Manual Part 70.

7. Copper-Covered Steel Guy and Messenger Strand—Specification 173, Manual Part 69.

8. Single-Conductor, Asbestos Varnished-Cambric Insulated Signal Wire with Flame-Retarding Braid Covering—Specification 192, Manual Part 187.

9. Single-Conductor Insulated Wire and Cable with Flame-Retarding, Moisture-Resistant or Weather-Resistant Braid Covering or Outer Polychloroprene Sheath—Specification 111, Manual Part 186.

10. Aerial Aluminum Cable Steel Reinforced—Specification 54, Manual Part 24.

11. Multiple-Conductor Insulated Cable with Weather-Resistant or Flame-Retarding Moisture-Resistant Braid Covering—Specification 89, Manual Part 25.

12. Multiple-Conductor Insulated Submarine Cable, Lead Sheathed and Round Steel Armored—Specification 90, Manual Part 26.

13. Single and Multiple-Conductor Insulated Lead Sheathed Cable—Specification 91, Manual Part 28.

14. Single and Multiple-Conductor, Insulated, Lead-Covered Parkway Cable, Armored with Flat Steel or Zinc Tape—Specification 145, Manual Part 20.

15. Single and Multiple-Conductor, Insulated, Non-Metallic Sheathed Cable—Specification 161, Manual Part 36.

16. Single and Multiple-Conductor, Insulated, Polychloroprene Compound Sheathed Cable—Specification 240, Manual Part 249.

17.

18.

35. *Size of wire.*

(a) Wire shall be of sufficient size to permit operation of switch and signal mechanisms in accordance with this specification.

(b) Single-conductor wires external to the interlocking station or instrument housings shall be not smaller than No. 14 A.W.G. Single-conductor wires within the interlocking station or instrument housings shall be not smaller than No. 16 A.W.G.

(c) Wires in cable external to the interlocking station shall be not smaller than No. 16 A.W.G.

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35. *Size of wire.*—Continued.

(d) Line wires shall be not smaller than No. 10 A.W.G. for hard-drawn copper or copper alloy, or No. 12 A.W.G. for copper-covered steel.

(e) In cables, spare wires shall be provided as designated by the Purchaser.

(f) Size and description of circuit conductors shall be as follows:

	Make (a)	A.W.G. (b)	Material (c)	Wall of rubber insula- tion (d)	Braid (e)	Tape (f)
1. Track transformers or batteries to rail.....						
2. Relay to each rail.....						
3. Fouling shunt connections.....						
4. Series track connections.....						
5. Switch circuit controller shunt connections.....						
6. Line drops.....						
7. Power line drops.....						
8. Signal wires.....						
9. Switch wires.....						
10. Ground wires.....						
11. Signal lighting wires.....						
12. Inside wiring (cases, etc.).....						
13. Aerial wire.....						
14. Transmission line.....						
15. C.T.C. line.....						
16. Relay leads.....						
17. Aerial cables.....						
18. Underground cables.....						
19. Submarine cables.....						
20.						

36. *Wiring.*

(a) Wiring shall be in accordance with Specification 119, Manual Part 84.

(b) Lead cable underground without other mechanical protection shall be placed in conduit.

(c) Wiring shall be handled in accordance with Instructions for Wire and Cable, Manual Part 190.

37. *Fuses.*

(a) Fuses shall be:

	Type	Voltage	Capacity
1.			
2.			

37. *Fuses.*—Continued.

(b) Fuse clips shall be mounted on an insulating base of fire-proof material.

(c) Necessary fuses to properly protect all apparatus and circuits, as required by the Purchaser, shall be installed by the Contractor. *R-37-c.

(d) Fuses outside of buildings shall be enclosed in weather-proof boxes.

(e) Entrance fuses in buildings shall be enclosed in fireproof compartments.

38. *Signals.*

(a) Signals shall be of type.

(b) Semaphore signal shall have an arm travel of deg. in the upper quadrant. *R-38-b.

(c) Semaphore castings shall be mounted on square section of shaft. Operating arm shall be mounted on square section of shaft or otherwise securely fastened.

(d) Enameled steel signal blades shall conform to Drawings 1548 and 1568. *R-38-d.

(e) Wood signal blades shall conform to Drawing 1065. *R-38-e.

(f) Signals shall be in accordance with the following specifications and drawings, where applicable:

1. Electric Motor Semaphore Signal—Specification 79, Manual Part 144.

2. Color Light Signal—Specification 80, Manual Part 146, or Specification 157, Manual Part 93.

3. Position Light Signal—Specification 81, Manual Part 147.

4. Color Position Light Signal—Specification 162, Manual Part 50.

5. Bolt and Clamp for 5-Inch Masts—Drawing 1083.

6. Filler Block—Drawings 1090, 1091 and 1092.

7. Ladders—Drawings 1365, 1366, 1583, 1619 and 1620.

8. Ladder Foundations—Drawing 1052.

9. Adapter-Base for Ground Mast Bottom Mechanism Signals—Drawing, dated

10. Base for Mast—Drawings 1059, 1178, 1447, 1448, 1449 and 1690.

11. Details and Assembly of Marker Lights—Drawing 1238.

12. Grade Signal Marker—Drawing 1612.

13. Take Siding Indicator—Dimensions and Lettering—Drawing 1551.

14. Electric Light Unit for Semaphore Lighting—Drawing 1446.

* Alternate requisites section.

38. *Signals.*—Continued.

(g) Signals shall be aligned to give the best view to approaching trains as determined by the Purchaser.

(h) Before signals are erected, the Purchaser shall, in the presence of the Contractor's representative, designate the location of each signal.

(i) Signals and fittings not otherwise specified shall be in accordance with Manufacturer's recommended design subject to approval of the Purchaser.

39. *Numerals, letters and brackets.*

(a) Numerals, letters and brackets shall conform to Drawings 1557 and 1558. *R-39-a.

40. *Signal lighting circuits.*

(a) The maximum allowable drop in potential on circuits to any lamp shall be 10 per cent.

(b) Alternating current distribution at volts, cycles shall be used. *R-40-b.

(c) Where primary battery is used for lighting, voltage regulators shall be used. *R-40-c.

(d) Incandescent lamp types and ratings shall be specified by Purchaser.

41. *Special circuits.*

(a) Special circuit requirements, in detail, are as follows:

1.
2.

42. *Electric lamps.*

(a) Incandescent electric lamps shall be in accordance with Specification 51, Manual Part 91, and conform to Drawings 1541, 1542 and 1543.

43. *Roundels, lenses and glass slides.*

(a) Roundels, lenses and glass slides shall be in accordance with Specification 69, Manual Part 136, and conform to Drawing 1414.

(b) The following colors shall be used:

Indication	Color
1.	
2.	

(c) Roundels shall be securely fastened in the spectacles in a manner satisfactory to the Purchaser.

44. *Signal bridges.*

(a) Signal bridges shall conform to Drawing, dated

* Alternate requisites section.

45. *Switch operating mechanism.*

(a) Switch operating mechanism shall be in accordance with the following:

1. Electro-Pneumatic Switch Operating Mechanism—Specification 152, Manual Part 30.
2. Electric Motor Switch Operating Mechanism—Specification 101, Manual Part 104.

(b) The distance from track and the location of the switch operating mechanism shall be as designated by Purchaser.

46. *Switch adjustments.*

(a) Switch adjustments shall conform to Drawing , dated

(b) Switches, derails and movable point frogs shall be provided with switch adjustments fastened to the No. 1 switch rod.

47. *Mechanical connections.*

(a) Arrangement and support of connections shall be such that switch, derail or movable point frogs can be stopped by placing an obstruction between point and stock rail at any point of stroke without breaking or bending such connections.

(b) The operating or the lock rods shall be of sufficient strength to alone and independently hold the switch points in position.

48. *Relays.*

(a) Time element relays shall be in accordance with Specification 197 or 202, Manual Parts 1 and 2.

(b) Direct current relays.

1. Tractive armature direct current neutral relays shall be in accordance with the following specifications:

(a) Two or More Contact Fingers—Specification 105, Manual Part 123.

(b) Two Contact Fingers—Specification 154, Manual Part 101.

(c) Biased Neutral—Specification 228, Manual Part 232.

(d) Interlocking—Specification 186, Manual Part 105.

(e) Plug-In Type—Specification 204, Manual Part 77.

(f) Flasher Type—Specification 185, Manual Part 143.

(g) For Non-Vital Circuits—Specification 224, Manual Part 228.

(h) Detachable Type for Use in Non-Vital Circuits—Specification 180, Manual Part 145.

2. Tractive armature direct current polarized relays shall be in accordance with Specification 165, Manual Part 137.

48. *Relays.*—Continued.

3. Tractive armature direct current retained neutral polarized relays shall be in accordance with Specification 221, Manual Part 231.

(c) Alternating current relays.

1. Alternating Current Induction Type Relay—Specification 78, Manual Part 122.

2. Alternating Current Power Transfer Relay—Specification 148, Manual Part 53.

(d) Code relays and transmitters.

1. Alternating Current Motor-Operated Code Transmitter—Specification 210, Manual Part 214.

2. Direct Current Code Transmitter—Specification 211, Manual Part 215.

3. Direct Current Code-Following Polar Relay—Specification 212, Manual Part 216.

(e) Other types of relays.

1. Other types of relays shall be as follows:

(a)

(b)

49. *Time releases.*

(a) Mechanical time releases shall be installed as required by the Purchaser and shall be in accordance with Specification 128, Manual Part 129.

(b) Setting of time releases shall be in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128. *R-49-b.

50. *Reactors and resistors.*

(a) Reactors shall be in accordance with Specification 104, Manual Part 121.

(b) Resistors shall be in accordance with Specification 106, Manual Part 135.

51. *Circuit controllers.*

(a) Universal switch circuit controllers shall be in accordance with Specification 95, Manual Part 49. *R-51-a.

(b) Switch circuit controller connections shall conform to Drawings 1255, 1256, 1271 and 1272. *R-51-b.

(c) Switch circuit controllers shall be connected to the normally closed switch point.

(d) Mechanical lever circuit controllers shall be in accordance with Specification 138, Manual Part 197.

(e) Movable bridge circuit controllers shall be in accordance with Specification 130, Manual Part 48.

(f) circuit controllers shall be in accordance with

* Alternate requisites section.

52. *Electric locks.*

(a) Electric locks for interlocking machines shall be in accordance with Specification 99, Manual Part 96.

(b) Electric switch lock shall be in accordance with Specification 198, Manual Part 109.

53. *Indicators, indication lights and illuminated track diagram.*

(a) Indicators, indication lights and illuminated track diagram shall be as follows:

1. Indicators type.

2. Indication lights design.

3. Illuminated track diagram design shall be installed in accordance with Drawing, dated

(b) Switch indicators shall be in accordance with

54. *Annunciators, annunciator bells.*

(a) Annunciators shall be of the following type:

1.

2.

(b) Annunciator bells shall be of the following type:

1.

2.

55. *Capacitors for power factor improvement.*

(a) Capacitors for power factor improvement shall be in accordance with Specification 160, Manual Part 100.

56. *Automatic train or time recorder.*

(a) Automatic train or time recorder, when installed, shall be in accordance with Purchaser's requirements.

57. *Bonding.*

(a) Track circuit bonding shall be in accordance with Specification 135, Manual Part 22.

58. *Insulated rail joints.*

(a) Insulated joints shall be type and for section, lb. rail with hole drilling.

(b) Insulated joints shall be installed in accordance with Instructions for Insulated Rail Joints, Manual Part 133.

(c) Insulated joints shall be located as shown on Drawings 1634, 1635, 1636, 1637 and 1638.

59. *Bootlegs.*

(a) Bootlegs shall conform to Drawing, dated

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60. *Track circuit connectors.*

- (a) Track circuit connectors shall conform to Drawings 1047, 1048, 1631 or 1632. *R-60-a.

61. *Fouling circuits.*

- (a) Fouling protection of turnouts and crossovers shall conform to Form 7004, Manual Part 206. *R-61-a.

62. *Impedance bonds.*

- (a) Impedance bonds shall be in accordance with Specification 74, Manual Part 67.
(b) Insulating compound for use in impedance bonds shall be in accordance with Specification 77, Manual Part 111.
(c) Insulating oil for use in impedance bonds shall be in accordance with Specification 217, Manual Part 222.

63. *Coded system track circuit unit.*

- (a) Coded system track circuit unit shall be in accordance with the following:
1. Non-Resonant—Specification 219, Manual Part 202.
2. Resonant—Specification 207, Manual Part 213.

64. *Coded system filters.*

- (a) Coded system filters shall be in accordance with the following:
1. Low Pass—Specification 225, Manual Part 229.
2. Voice Pass—Specification 233, Manual Part 240.
3. Voice and Carrier Pass—Specification 235, Manual Part 242.
4. Voice and Type H Pass—Specification 234, Manual Part 241.
5. Other filters shall be as follows:
(a)
(b)

65. *Communication system.*

- (a) Telephone system shall be in accordance with A.A.R. Communications Section Specification.
(b) Telephones or telephone jacks shall be located in suitable housings at switch and signal locations as specified by Purchaser.
(c) Loud speaker equipment shall be installed as specified by Purchaser.
(d) Selector equipment shall be installed as specified by Purchaser.
(e) Teletype system shall be installed as specified by Purchaser.
(f) system shall be installed as specified by Purchaser.

* Alternate requisites section.

66. *Control and communication circuits.*

(a) Purchaser will designate which circuits shall be single wire, single break, or double wire, double break, and furnish the following typical circuit plans which the Contractor is to follow, or where the Contractor's standard practice or plans are followed, the Purchaser will approve plans before work is started:

1. Signal control.
2. Signal indication.
3. Signal lighting.
4. Switch control.
5. Switch indication.
6. Approach locking.
7. Traffic locking.
8. Sectional locking.
9. Route locking.
10. Route locking with sectional release.
11. Time locking.
12. Lever light indication.
13. Track.
14. Communication.
15.
16.

67. *Carrier systems for control of remote sections.*

(a) Purchaser will designate territory limits of carrier circuits.
(b) Carrier equipment shall be installed as specified by Purchaser.

(c) Carrier equipment shall be in accordance with Manufacturer's specifications, modified to meet Purchaser's requirements.

(d) Carrier channel power levels, frequencies and transpositions shall be in accordance with recommendations of the Communications Section, A.A.R.

68. *Line material.*

(a) Cross-arms and pole line hardware shall be in accordance with A.A.R. Communications Section Specifications.

(b) Insulators for distribution system shall be of type, material.

(c) Insulators for low-voltage circuits shall be of type, material.

(d) Pin type porcelain insulators shall be in accordance with Specification 146, Manual Part 160.

69. *Instrument housings.*

(a) Instrument housings shall conform to the following drawings:

1. Cable Post—Drawing 1192.
2. Relay Box Inlet Bracket—Drawing, dated

69. *Instrument housings.*—Continued.

3. Relay Box Linings and Terminal Boards—Drawing , dated
4. Relay Box Fittings—Drawing , dated
5. Relay Box and Cable Post Mountings—Drawing , dated
6. Steel Instrument House—Drawing 1602.
7. Steel Instrument Case—Drawing 1601, 1626, 1627 or 1628.
8. Concrete housing shall conform to Drawing , dated
9. Relay racks shall conform to Drawing , dated
10.

70. *Battery housings.*

- (a) Battery housings shall conform to Drawing , dated
- (b) Concrete battery boxes shall conform to Drawings 1266, 1267, 1268 and 1269.
- (c) Battery racks shall conform to Drawing , dated

71. *Junction boxes.*

- (a) Junction boxes shall conform to Drawing , dated
- (b) Junction boxes shall be located as shown on Drawing , dated

72. *Terminal boxes.*

- (a) Terminal boxes shall conform to Drawing , dated

73. *Conduits.*

- (a) Conduits shall be in accordance with the following:
 1. Specification for Fibre Conduit—Manual Part 37.
 2. Specification for Communication Underground Conduit Construction—Manual Part 38.
 3. Specification for Steel Pipe Conduit—Manual Part 39.
 4. Specification for Wrought Iron Pipe Conduit—Manual Part 40.
 5. Specification for Vitrified Clay Conduit—Manual Part 41.

74. *Wire chases.*

- (a) Wire chases and conduits within the interlocking or control station shall be of fireproof construction. Provision shall be made by the Purchaser in the walls and floors for proper housing of all wires between machine and relay case and between relay case and first pull box outside of station.

75. *Padlocks.*

(a) Purchaser's padlocks shall be furnished by and shall be used where specified by Purchaser.

76. *Switch-rod insulation.*

(a) Switch-rod insulation shall conform to Drawing 1055.
*R-76-a.

77. *Pipe-line insulation.*

(a) Pipe-line insulation shall conform to Drawing 1094.
*R-77-a.

78. *Fibre insulation.*

(a) Fibre insulation shall be in accordance with Specification 13, Manual Part 58.

79. *Front rods.*

(a) Front rods shall be of the solid adjustable type. *R-79-a.

80. *Lock rods.*

(a) Lock rods shall conform to Drawing 1587. *R-80-a.
(b) Notches in lock rods and ends of plungers or locking dogs shall have square edges.
(c) Lock rods shall run direct from front rods or switch lugs into lock stands.

81. *Gage and butt plates.*

(a) Gage plates shall be 1 in. by 7 in. merchant bar steel.
*R-81-a.

(b) Gage plates shall be insulated. Insulation shall conform to Drawing 1373.

(c) Butt plates shall be merchant bar steel 1 in. by 3 in. by 7 in., drilled for three $\frac{3}{4}$ in. rivets, middle rivet staggered.
*R-81-c.

(d) Not less than one gage plate shall be used for each switch and split point derail and shall be located on point tie. *R-81-d.

(e) Not less than four gage plates shall be used for each set of movable point frogs and shall be so located that one plate will be placed on point tie and one on first tie back of point tie for each pair of points. *R-81-e.

(f) Gage plates shall be fitted in place and securely fastened to the ties with lag screw spikes conforming to Drawing 1381.
*R-81-f.

(g) Ties supporting lifting type derails shall be equipped with gage plates.

(h) Gage plates shall be drilled to provide for spiking and holding points of switches, derails and movable point frogs securely to stock rail in either position.

(i) Contractor shall ascertain from Purchaser correct gage of track before fitting gage plates to any switch, derail or movable point frog.

* Alternate requisites section.

82. *Rail braces.*

- (a) Rail braces shall be adjustable of the type.
*R-82-a.
- (b) Rail braces shall be used on gage or switch plates.

83. *Tie straps.*

- (a) Tie straps shall be $\frac{3}{4}$ in. by $2\frac{1}{2}$ in. merchant bar steel.
- (b) Tie straps shall be used at all switches, derails and movable point frogs, to tie all crank, rocking shaft, switch point and intermediate ties together, placed, if practicable, 10 in. from base of rail, and fastened to each tie with one lag screw $\frac{3}{4}$ in. diameter by not less than $4\frac{1}{2}$ in. long.

84. *Bolts, screws and washers.*

- (a) Bolts, tap bolts, set screws and machine screws shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17.
- (b) Lag screws shall be standard, with gimlet points and square heads.
- (c) Flat washers shall be standard cut.
- (d) Cast washers shall conform to Drawing 1458.
- (e) Lock washers shall be of type approved by Purchaser.
- (f) Lag screw spike shall conform to Drawing 1381.
- (g) Lag screws shall be screwed their entire length into holes previously filled with creosote oil. These holes shall be bored small enough to provide full thread.
- (h) Flat washers shall be used under boltheads, nuts and screws where they come in contact with wood.
- (i) Spring lock washers shall be used under nuts as follows:
 - 1.
 - 2.

85. *Foundations.*

- (a) The Purchaser will, in the presence of the Contractor's representatives, designate the location of each foundation.
- (b) Foundations shall be rigid, level and parallel to track.
- (c) Elevation and distance of foundations from track shall be in accordance with Purchaser's standard practice.
- (d) Foundations for ground mast signals and instrument cases shall conform to Drawings 1107 and 1259. *R-85-d.
- (e) Foundations not otherwise specified shall be in accordance with Purchaser's standard.
- (f) Concrete foundations shall be allowed to properly set before any apparatus is connected thereto or placed thereon.
- (g) Foundations shall be so constructed that apparatus can be removed without disturbing foundations.

* Alternate requisites section.

85. *Foundations.*—Continued.

(h) Dimensions for foundations shall be applicable to level and solid ground. The Purchaser and Contractor shall jointly decide when deviations from specified sizes are necessary.

(i) Foundations shall be provided by _____, in accordance with Specification _____, dated _____, and Drawing _____, dated _____.

86. *Anchor bolts.*

(a) Anchor bolts for ground mast signals shall conform to Drawing 1107 or 1259.

(b) Anchor bolts for other foundations shall be in accordance with Purchaser's standard.

(c) Threads of anchor bolts shall not be embedded in concrete foundations.

(d) Bolt holes in signal base castings shall be filled with pitch or equivalent waterproof and rust-resisting compound.

87. *Concrete.*

(a) Concrete shall be 1-2-4 mixture and in accordance with Specification _____, dated _____. *R-87-a.

88. *Trunking.*

(a) Trunking shall be of material and sizes as follows:

	Material	Size
1.	_____	_____
2.	_____	_____

(b) Untreated wood trunking shall be in accordance with Specification _____, dated _____.

(c) Treated trunking shall be in accordance with Specification _____, dated _____.

(d) Installation of trunking shall conform to Drawing _____, dated _____.

(e) Permission shall be obtained from Purchaser to place between tracks, runs of trunking parallel with the tracks.

(f) Trunking when on stakes above ground and running parallel with the track, shall not be placed nearer than 6 ft. from the gage side of the nearest rail except by Purchaser's permission.

(g) Local conditions shall determine the height of trunking when above ground; in general, when trunking runs parallel with the tracks, bottom of trunking shall be placed not less than 6 in. above ground. Trunking crossing tracks and parallel to rails between tracks shall have top approximately level with top of ballast.

(h) Trunking in main runs shall have $\frac{1}{2}$ in. hole through bottom of trunking between each stake or foundation for drainage. All other runs shall be so installed that there will be sufficient slope for drainage.

* Alternate requisites section.

88. *Trunking.*—Continued.

(i) Nails shall not be driven through the trunking from the inside of the groove nor shall they be driven into the groove from the outside.

(j) Inside corner of trunking, at turns, must be rounded to prevent insulation on wires being injured.

(k) Surfaces of trunking that are to be painted shall be finished.

(l) Not less than 25 per cent of the capacity of the groove shall remain free for the further installation of wires. *R-88-1.

(m) Capping shall be securely fastened to trunking as follows:

1.
2.

89. *Joints in wood trunking.*

(a) Joints in wood trunking shall be made in accordance with Drawing, dated

(b) Joints in separate parts of trunking shall be staggered at least 1 ft.

(c) Joints in capping shall be made at least 1 ft. from joint in trunking.

90. *Supports for wood trunking.*

(a) Supports for trunking shall be of material and sizes as follows:

	Material	Size
1.		
2.		

(b) Stakes shall be not less than 3 in. by 4 in. or of equivalent circular section. When stakes of a greater length than 3 ft. 6 in. or greater cross-section than 3 in. by 4 in. are necessary, information as to the number, length and cross-section will be furnished by the Purchaser.

(c) Trunking above ground shall have supports placed not more than ft. centers.

(d) When trunking exceeds a width of 7 in., additional supports shall be provided as follows:

(e) Stakes shall be placed vertically and extend a sufficient distance into the ground to rigidly support the trunking to the satisfaction of the Purchaser.

(f) A piece of capping 8 in. long and the width of trunking shall be placed between the trunking and each support.

(g) Each joint in the bottom of the trunking shall have a support.

(h) When trunking is extended across ditch or other depression necessitating a span of more than 5 ft. it shall be reinforced by a piece of timber 4 in. by 6 in. laid horizontally and with suitable supports under reinforcing piece.

* Alternate requisites section.

90. *Supports for wood trunking.*—Continued.

(i) Exposed trunking crossing under tracks containing other than track circuit wires shall be protected by metal covering between rails. *R-90-i.

91. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

92. *Special items.*

(a)

Alternate requisites.

R-3-d.

Framed track diagram shall be furnished in place by Contractor, in interlocking station.

R-3-e.

Manipulation chart shall be furnished in place by Contractor, in interlocking station.

R-3-g.

After the award of contract and before work is begun, the Purchaser shall furnish the following drawings as scheduled by the Purchaser:

- (a) Track plan showing switches, signals, relays, transformers, and batteries and their locations, within days.
- (b) Detail circuit plans, within days.
- (c) Instrument case wiring plans, within days.
- (d) Cable diagrams, within days.
- (e) Pole line diagrams, within days.

R-7-a.

Contractor will furnish transportation for men, necessary for the installation, over the following lines:

- 1.
- 2.

R-7-b.

Contractor will furnish transportation for tools and material, necessary for the installation, over the following lines:

- 1.
- 2.

R-7-c.

Purchaser will not furnish work train service for distribution of material.

* Alternate requisites section,

Alternate requisites.—Continued.

R-7-d.

Purchaser will not furnish work train service for erection of apparatus.

R-10-a.

Purchaser will place the installation in service in the event that he does not authorize the Contractor to do so within days after completion of the work to the Purchaser's satisfaction.

R-12-a.

Clearances shall conform to Purchaser's clearance diagram, Drawing, dated

R-17-a.

Switchboard shall be in accordance with
.....

R-21-a.

Motor-generator shall not be direct-connected.

R-22-a.

Air compressor shall not be furnished.

R-22-b.

Foundation for compressor, if required, shall be furnished by Purchaser.

R-22-c.

Automatic governors shall not be provided.

R-22-e.

Duplicate panels for control of air compressors shall not be provided.

R-22-f.

Air compressors shall be driven.

R-23-b.

Extra large reservoirs called expansion tanks to provide a stand-by air supply shall not be used.

R-24-a.

Air line shall be

R-24-a-1.

Main air lines shall be inches in diameter.

R-24-a-2.

Branches to switches shall be inches in diameter.

Alternate requisites.—Continued.

- R-24-a-3. Branches to signals shall be inches in diameter.
- R-24-d. Expansion joints for pipes 2 inches in diameter or larger shall have
- R-24-e. Gate or globe valve shall have
- R-24-f. Stop cocks, screw unions, combination stop cocks and screw unions for $\frac{3}{4}$ in. pipe or smaller shall be
- R-24-k. Expansion joints shall be placed in the main air line not more than ft. apart where pipe is located above ground and ft. where pipe is located underground.
- R-24-o. Air filter shall not be furnished between each branch line and pneumatically operated unit.
- R-25-a. Condensers shall be of the type.
- R-37-c. Fuses shall be installed as follows:
- R-38-b. Semaphore signal shall have an arm travel of deg. in the lower quadrant.
- R-38-d. Steel signal blades shall conform to
- R-38-e. Wood signal blades shall conform to
- R-39-a. Numerals, letters and brackets shall conform to Drawing , dated
- R-40-b. Direct current distribution at volts shall be used.

Alternate requisites.—Continued.

R-40-c.

Where primary battery is used for lighting, voltage regulators shall not be used.

R-49-b.

Setting of time releases shall be

R-51-a.

Switch circuit controllers shall be

R-51-b.

Switch circuit controller connections shall conform to

R-60-a.

Track circuit connectors shall conform to Drawing, dated

R-61-a.

Fouling protection of turnouts and crossovers shall conform to Drawing, dated

R-76-a.

Switch-rod insulation shall conform to Drawing, dated

R-77-a.

Pipe-line insulation shall conform to

R-79-a.

Front rods shall be

R-80-a.

Lock rods shall conform to

R-81-a.

Gage plates shall be bar steel.

R-81-c.

Butt plates shall be

R-81-d.

Gage plates shall not be used on switches and split point derails.

R-81-e.

Not less than gage plates shall be used for each set of movable point frogs and shall be so located that one plate will be placed on point tie.

Alternate requisites.—Continued.

R-81-f.

Gage plates shall be fitted in place and securely fastened to the tie with

R-82-a.

Rail braces shall be non-adjustable of the type.

R-85-d.

Foundations for ground mast signals and instrument cases shall conform to Drawings, dated

R-87-a.

Concrete shall be mixture in accordance with Specification, dated

R-88-1.

Not less than per cent of the capacity of the groove shall remain free for the further installation of wires.

R-90-i.

Exposed trunking crossing under tracks shall not be protected by metal covering between rails.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of A.A.R. Signal Section Specification 149-43)

SPECIFICATION FOR CENTRALIZED TRAFFIC CONTROL

1951

Centralized traffic control installations shall be made in accordance with provisions outlined in Specification 258, Manual Part, modified as required.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 149-43—Centralized Traffic Control,
Manual Part 97.

(Revision of A.A.R. Signal Section Specification 67-43)

SPECIFICATION FOR ELECTRO-PNEUMATIC INTERLOCKING

1951

Electro-pneumatic interlocking installations shall be made in accordance with provisions outlined in Specification 258, Manual Part, modified as required.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 67-43—Electro-Pneumatic Interlocking,
Manual Part 79.

(Revision of A.A.R. Signal Section Specification 65-42)

SPECIFICATION FOR ELECTRIC INTERLOCKING

Electric interlocking installations shall be made in accordance with provisions outlined in Specification 258, Manual Part, modified as required.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 65-42—Electric Interlocking, Manual Part 75.

(Revision of A.A.R. Signal Section Specification 141-43)

SPECIFICATION FOR AUTOMATIC INTERLOCKING

1951

Automatic interlocking installations shall be made in accordance with provisions outlined in Specification 258, Manual Part, modified as required.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 141-43—Automatic Interlocking,
Manual Part 208.

(Revision of A.A.R. Signal Section Specification 203-44)

SPECIFICATION FOR ALL-RELAY INTERLOCKING

1951

All-relay interlocking installations shall be made in accordance with provisions outlined in Specification 258, Manual Part, modified as required.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 203-44—All-Relay Interlocking,
Manual Part 209.

(Revision of A.A.R. Signal Section Specification 66-41)

SPECIFICATION FOR ELECTRO-MECHANICAL AND
MECHANICAL INTERLOCKING

1951

Electro-mechanical and mechanical interlocking installations shall be made in accordance with provisions outlined in Specification 258, Manual Part, modified and to include the following, as required:

1. *Details of work.*

(a) Details of work include the following:

1. Lead-out.
2. Pipe lines.
3. Switch-and-lock movements.

2. *Drawings.*

(a) Contractor's drawings.

1. After the award of contract and before work is begun, the Contractor shall furnish for the approval of the Purchaser, the following drawings as scheduled by the Purchaser (*R-2-a-1):

- (a) Lead-out and pipe line plans within days.
- (b)

3. *Interlocking machine.*

(a) One mechanical lever shall operate not more than:

1. One mechanical signal.
2. One single switch.
3. One end of slip switch.
4. One movable point frog.
5. One switch-and-lock movement.
6. One eight-way mechanical bridge coupler.
7. A combination of rail locks, bridge locks, mechanical bridge couplers when the total load of such combination does not exceed the load of one eight-way mechanical coupler.

4. *Lead-out.*

(a) Lead-out shall be rocking shaft. *R-4-a.

(b) Down rods shall be of $1\frac{1}{2}$ in. steel pipe, with one solid and one screw jaw tanged.

(c) Down rods shall be vertical and without support.

(d) Lead-out appliances shall be securely fastened to lead-out supports with $\frac{3}{4}$ in. bolts, with boltheads underneath. Lock washers shall be used where practicable.

* Alternate requisites section.

5. *Cranks.*

- (a) Vertical cranks shall conform to Drawings 1007 and 1067.
- (b) Horizontal cranks shall conform to Drawings 1007, 1008 and 1393.
- (c) Cranks for main pipe lines shall be drilled $11\frac{3}{4}$ in. by $11\frac{3}{4}$ in. centers, and not more than one crank shall be mounted on a pin.

6. *Deflecting bars.*

- (a) Vertical deflecting bars shall conform to Drawing _____, dated _____.
- (b) Horizontal deflecting bars shall conform to Drawing _____, dated _____.

7. *Rocking shafts and fittings.*

- (a) Rocking shafts and fittings shall conform to Drawings 1060, 1061, 1062 and 1063.
- (b) Rocking shaft shall be supported by a bearing at each end and by intermediate bearings where necessary, in order that not more than 6 ft. of shaft shall be unsupported.
- (c) Rocking shaft bearings shall be securely bolted to foundations with four $\frac{3}{4}$ in. bolts, except in case of four-way bearings which shall have six $\frac{3}{4}$ in. bolts.

8. *Pipe and pipe lines.*

- (a) One-inch pipe, couplings, plugs and rivets shall be in accordance with Specification 122, Manual Part 114. *R-8-a.
- (b) Pipes shall be screwed in couplings until ends abut.
- (c) One-inch pipe shall be used for connections to switches, derails, movable point frogs, locks, bridge operating and locking devices, and mechanically operated signals. Where solid connections are required, $11\frac{1}{32}$ in. round iron shall be used.
- (d) Pipe line shall be in alignment, with nearest pipe not less than 6 ft. from gage of nearest rail, except where authority to deviate is granted by the Purchaser. On movable bridges and approaches they shall be kept as far from gage line as conditions will permit.
- (e) Where practicable, pipes in main line shall be so run that they will lead off on track side in regular order.
- (f) Top of pipe carrier foundation in main pipe line shall be level with base of rail where conditions will permit.
- (g) Cranks and compensators in main pipe run shall be so located as to leave field side clear for trunking and additional pipe lines.
- (h) Pipe lines shall be laid $2\frac{3}{4}$ in. centers and shall be supported on pipe carriers placed not more than 8 ft. centers on tangents and curves up to 2 deg. On curves of 2 deg. or more they shall be spaced not more than 7 ft. centers.

* Alternate requisites section.

8. *Pipe and pipe lines.*—Continued.

(i) With the lever in the center position of stroke, the couplings in pipe line shall be located not less than 12 in. from pipe carriers.

(j) Where so specified, "I" beam track supports shall be used where pipe lines cross under tracks, and construction shall conform to Drawing, dated, and shall be furnished in place by Purchaser. *R-8-j.

(k) Pipe lines running under tracks shall be arranged to permit standard spacing and proper tamping of ties, except where otherwise provided, and top of pipe shall be not less than 1 in. below base of rail.

(l) Turns in pipe lines shall be made with deflecting bars, radial arms or cranks, as follows:

Angle of deflection, deg.	Bar, deg. with eye ends	Radius, in.
15 to $33\frac{3}{4}$	$22\frac{1}{2}$	$80\frac{1}{4}$
$33\frac{3}{4}$ to $52\frac{1}{2}$	45	$40\frac{1}{8}$
$52\frac{1}{2}$ to $67\frac{1}{2}$	60	$30\frac{1}{16}$
$67\frac{1}{2}$ to 80	75	$24\frac{1}{16}$
80 to 90	85	21

Deg.	Radial arms and cranks
0 to 30	15 deg. radial arm cranks
30 to 75	60 deg. acute angle cranks
75 to 105	90 deg. right angle cranks
105 to 140	120 deg. obtuse angle cranks
140 to 180	180 deg. equalizing arms

(m) Deflecting bars shall not be used at any point where the total movement of the pipe line, due to stroke, expansion and contraction, is more than 11 in.

(n) Offset in body of jaw shall not exceed $2\frac{3}{4}$ in.

(o) Offset in double tang ends, between any two supports, shall not exceed $3\frac{1}{2}$ in.

(p) Offsets shall be made in body of jaws or double tang ends.

(q) Offsets in cranks shall be avoided as far as practicable.

9. *Stuffing boxes.*

(a) Stuffing boxes for 1 in. pipe shall conform to Drawing 1225.

(b) Where 1 in. pipe is installed in pipe, it shall be encased in 2 in. galvanized wrought iron pipe. The 2 in. pipe shall be provided at each end with a stuffing box and filled with non-freezing oil. *R-9-b.

(c) Ends of pipe filled with oil shall be securely anchored.

(d) The 1 in. operating pipe installed inside of 2 in. pipe shall have inside pipe carriers spaced approximately 7 ft. centers. *R-9-d.

* Alternate requisites section.

10. *Pipe carriers.*

(a) Pipe carriers shall conform to Drawings 1072, 1073, 1074, 1075, 1084 and 1085.

(b) Transverse pipe carriers supporting pipe leading under track shall be placed not more than 7 ft. centers.

(c) Transverse pipe carrier supports shall be fastened to ties with two $\frac{3}{4}$ in. by 4 in. lag screws.

(d) Pipe carriers for main pipe runs shall be fastened to metal tops with two $\frac{1}{2}$ in. bolts.

(e) Strap pipe carriers shall be fastened to supports with two $\frac{1}{2}$ in. by $2\frac{1}{2}$ in. lag screws.

11. *Compensators.*

(a) Compensators shall conform to Drawings 1013 and 1014.

(b) Pipe compensation shall be in accordance with Specification 121, Manual Part 113.

12. *Jaws and lugs.*

(a) Jaws and lugs shall conform to Drawings 1016, 1017, 1018 and 1019.

(b) Solid jaws shall be used for all pipe connections except where otherwise specified.

13. *Pipe adjustments.*

(a) Pipe adjusting screws and screw jaws shall conform to Drawings 1002, 1016 and 1019.

(b) Screw jaws or pipe adjusting screws shall be used in each pipe line as follows:

1. One for each plunger lock.
2. One for each switch-and-lock movement.
3. One for each high signal.
4. One for each dwarf signal.
5. One for each bridge lock and coupler.
6. One for each bridge coupler.
7. One for each rail lock or rail lock slide bar.
8. One on each side of bridge coupler for through connection.
9. One for each bolt lock connection to switch.
10. One at each end of bolt lock bar.
11. One for each plunger connection.
12. One for each lifting derail.
13.
14.

(c) Pipe adjusting screws shall be located as near as practicable to the units to be adjusted, without being directly under the track rails, guard rails, frogs, switches or bridge guards, and shall not be adjacent to each other.

14. *Pins and cotters.*

- (a) Jaw, crank and compensator pins shall conform to Drawing 1010.
- (b) Cotters shall conform to Drawing 1409.
- (c) All pins shall be provided with cotters, properly spread.

15. *Foundations.*

- (a) Foundations shall be set parallel to pipe line.
- (b) Pipe carrier foundations shall be provided with metal tops.
- (c) One pipe carrier foundation shall be used for not more than six pipe lines and one additional foundation for each seven or less additional pipe lines.

16. *Switch-and-lock movement.*

- (a) Switch-and-lock movements shall be provided with staggered locking for normal and reverse position of points.
- (b) Mechanically operated switch-and-lock movements shall be bolted to $\frac{5}{8}$ in. by 12 in. by 4 ft. 10 in. steel plate. The steel plate shall be bolted to ties with two $\frac{3}{4}$ in. bolts through each tie.
- (c) Switch-and-lock movements on the following switches shall be equipped with electric locks to prevent operation by dragging equipment:
 - 1.
 - 2.
- (d) The distance from track and the location of switch-and-lock movement shall be as designated by Purchaser.

17. *Plunger locks.*

- (a) Plunger lock stands and plungers shall conform to Drawing 1425.
- (b) Plunger locks shall be arranged to lock switches and movable point frogs in normal and reverse position and derails in position.
- (c) Plunger lock plungers shall have a stroke of not less than 8 in. and stand 1 in. clear of locking bar when lever is in normal position.

18. *Bolt locks.*

- (a) Bolt locks shall conform to Drawing, dated
- (b) Bolt lock rods shall be connected to point lug, Drawing 1255.
- (c) Bolt locks shall be used in connection with mechanically operated signals on facing switches, movable point frogs and derails, as specified by Purchaser.
- (d) The signal bar of bolt lock shall form a part of the pipe line operating the signal when switches located between the signal station and signal are bolt-locked; the signal bar of bolt lock shall not form a part of pipe line operating the signal when switches not located between signal station and signal are bolt-locked.

19. *Signals.*

(a) Dwarf signals shall conform to Drawing 1097. *R-19-a.

(b) Mechanical signal semaphore shaft shall be made of cold-rolled steel not less than 1 in. square. Drawing , dated

Alternate requisites.

R-2-a-1.

After the award of contract and before work is begun, the Purchaser shall furnish the following drawings as scheduled by the Purchaser:

(a) Lead-out and pipe line plans within days.

(b)

R-4-a.

Lead-out shall be:

1. Horizontal and vertical crank.

2. Deflecting bar.

3. Deflecting bar and vertical crank.

4. Deflecting bar and horizontal crank.

R-8-a.

One-inch pipe, couplings, plugs and rivets shall be in accordance with Purchaser's Specification, dated, and Drawing, dated

R-8-j.

Where so specified, "I" beam track supports shall be used where pipe lines cross under tracks, and construction shall conform to Drawing, dated, and shall be furnished in place by Contractor.

R-9-b.

Where 1 in. pipe is installed in pipe, it shall be encased in 2 in. pipe. The 2 in. pipe shall be provided at each end with a stuffing box and filled with non-freezing oil.

R-9-d.

One-inch operating pipe installed inside of 2 in. pipe shall be in ft. lengths without inside pipe carriers.

R-19-a.

Dwarf signals shall be

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 66-41—Electro-Mechanical and
Mechanical Interlocking, Manual Part 76.

* Alternate requisites section.

(Revision of A.A.R. Signal Section Specification 152-50)
A.A.R. SIGNAL SECTION SPECIFICATION 152-51.

ELECTRO-PNEUMATIC SWITCH OPERATING MECHANISM

Proposed Revision

5. Design and functional requirements.

(e) Mechanism.

3. Mechanism and case shall be so designed that lock rod may be readily removed. Ends of plunger or locking dogs and holes or notches in lock rod shall have square edges. Such holes or notches shall be not more than $\frac{1}{8}$ in. wider than the plunger. Locking dog of switch-and-lock movement shall extend through lock rod $\frac{3}{4}$ in. or more in either normal or reverse position.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Section 5-e-3 of Specification 152-50—Electro-Pneumatic Switch Operating Mechanism, Manual Part 30.

(Revision of Requisites for Movable Bridge Interlocking)
A.A.R. SIGNAL SECTION REQUISITES.

MOVABLE BRIDGE INTERLOCKING

1951

1. These requisites are for the purpose of setting forth the recommended general requirements for movable bridge interlocking.

2. All control circuits, the functioning of which affects safety of train operation, shall be designed on the closed circuit principle, except circuits for roadway equipment of intermittent automatic train stop system.

3. Each roadway signal shall be located over or to the right of the track it governs.

4. Aspects shall be shown by the position of semaphore blades, color of lights, position of lights, flashing of lights, or any combination thereof. They may be qualified by marker plate, number plate, letter plate, marker light, shape and color of semaphore blades or any combination thereof, subject to the following conditions:

(a) Night aspects of roadway signals, except qualifying appurtenances, shall be shown by lights; day aspects by lights or semaphore arms. A single white light shall not be used.

(b) Reflector lenses or buttons, or other devices which depend for visibility upon reflected light from an external source, shall not be used in night aspects, except qualifying appurtenances.

(c) The fundamental indications of signal aspects shall conform to the following:

1. A red light, a series of horizontal lights, or a semaphore blade in a horizontal position shall be used to indicate Stop.

2. A yellow light, a lunar light, or a series of lights or a semaphore blade in the upper or lower quadrant at an angle of approximately 45 deg. to the vertical, shall be used to indicate that speed is to be restricted and stop may be required.

3. A green light, a series of vertical lights, or a semaphore blade in a vertical position in the upper quadrant, or 60 or 90 deg. in the lower quadrant, shall be used to indicate Proceed at Authorized Speed.

5. Each roadway signal shall be located with respect to the next signal or signals in advance which govern train movements in the same direction so that the indication of a signal displaying a restrictive aspect can be complied with by means of a brake application, other than an emergency application, initiated at such signal, either by stopping at the signal where a stop is required, or by a reduction in speed to the rate prescribed by the next signal in advance where reduced speed is required.

6. Track circuits and route locking shall be provided throughout interlocking limits.

7. Mechanical locking, or the same protection effected by means of circuits, shall be provided.

8. Approach or time locking shall be provided.
9. Indication locking shall be provided for operative approach signals of the semaphore type, power-operated home signals, smashboards, derails, and for all approach signals except light signals, all aspects of which are controlled by coded track circuits or by double-wire line circuits.
10. Electric locking shall be provided for:
 - (a) Derails in non-derailing position.
 - (b) Signal devices which check rail surfacing and aligning devices and bridge locking mechanism.
 - (c) Movable bridge circuit controller, not operated by bridge device, closed.
 - (d) Mechanical bridge coupler closed.
11. Power machine for operating derails, devices which check the surface and alignment of rails, check bridge locking mechanism, or operate bridge circuit controller shall be provided with means to indicate on interlocking machine or to the operator when movement is completed and unit is locked.
12. Signal appliances shall be so interlocked with bridge devices that before a signal governing movements over the bridge can display an aspect to proceed the bridge and track must be aligned and locked, with the bridge locking members within 1 in. of their proper positions and with the track rail on the movable span within $\frac{3}{8}$ in. of correct surface and alignment with the rail on the bridge abutment or fixed span.
13. Signal devices shall be so interlocked or interconnected with bridge devices that no bridge device can be operated unless all signal devices have properly functioned to release the bridge.
14. Signal devices shall operate separately or in groups in the following sequence:
 - (a) To open movable span:
 1. Signal levers normal, home signals at Stop.
 2. Signal levers normal, smashboards at Stop.
 3. Derail levers normal, derails in derailing position.
 4. Devices for checking the surface and alignment of rail ends in non-checking position.
 5. Movable bridge circuit controllers and pipe couplers open.
 6. Bridge operating mechanism mechanically or electrically released, master lever reversed.
 - (b) To establish rail traffic:
 1. Bridge operating mechanism mechanically or electrically locked, master lever normal.
 2. Movable bridge circuit controllers and pipe couplers closed.
 3. Devices for checking the surface and alignment of rail ends in checking position.
 4. Derail levers reversed, derails in non-derailing position.
 5. Signal levers reversed, smashboards clear.
 6. Signal levers reversed, home signals clear.
15. Requisites for Interlocking, Manual Part 94, shall govern where applicable.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded

Requisites for Movable Bridge Interlocking, Manual Part 64.

(Revision of A.A.R. Signal Section Specification 76-49)
A.A.R. SIGNAL SECTION SPECIFICATION 76-51.

ELECTRIC INTERLOCKING MACHINE

1. *Purpose.*

(a) This specification is for the purpose of providing an electric interlocking machine for the control of signals, switches, and other interlocking units. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Requisites, specifications, drawings and instructions.*

(a) Requisites, specifications, drawings and instructions referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Track and signal plan drawn to scale.
2. Designation of levers, working and spare, and spare lever spaces.
3. Sequence for numbering of levers.
4. Control circuit characteristics including voltage, amperes and frequency requirements.
5. Electric lever locks and time releases.
6. Lever lights.
7. Color for enamel finish.
8. Special features.
9. Inspection and tests as required.
10. Alternate requisites as required.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

6. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

7. *Design.*

(a) Machine frame and locking bed shall be so designed that additional sections may be added on either end.

(b) Movable parts of machine shall work freely, without lost motion, and provisions made to permit proper and convenient lubrication.

(c) Parts of machine shipped knocked-down shall be marked with indented figures on a finished surface and given the numbers they take in the assembled machine. Numbers shall be visible in the assembled machine where practicable.

(d) For horizontal locking, the locking brackets, cross-locking and swing dogs shall be marked to permit reading from back of machine. Longitudinal bars shall be marked on top on both ends from front of machine for space number. Riveted dogs shall be marked on top with lever number. Cross-locking shall be marked on top with bracket number in center and number of longitudinal bars between which cross-locking extends at the ends. Swing dogs shall be marked with bracket number at the trunnion end and lever number at the nose end.

(e) For vertical locking, tappets and tappet jaws shall have their lever numbers marked on the front. Locking dogs and longitudinal bars shall have their lever and space number marked on the front.

(f) Like parts of same Manufacturer's machine shall be interchangeable.

(g) Bolts, nuts and threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17.

(h) Cap screw heads shall be hexagonal.

(i) Bolts and cap screws shall be provided with spring lock washers where practicable.

(j) Taper dowel pins shall be tapered $\frac{1}{4}$ in. per ft.

(k) When necessary to hold parts in fixed relation to each other, dowel pins or body-bound bolts, or both, shall be used.

8. *Levers.*

(a) Levers shall have equal and uniform throw and shall be true in alignment.

(b) Levers shall be so arranged that they can be removed without interfering with the operation of other levers.

(c) Levers shall be designed to latch in each operating position.

(d) Levers shall be designed to permit the application of electric locks and mechanical time releases independently of indication locks.

9. *Mechanical locking.*

(a) Locking bed shall be of ample size to accommodate future locking for spare levers and spaces.

9. *Mechanical locking.*—Continued.

(b) Locking shall be distributed as uniformly as possible without crowding and so arranged as to be accessible.

(c) Each lever space shall be fully equipped with locking brackets, or plates, cross-locking and locking bars.

(d) Direct locking shall be used wherever possible.

(e) Dogs for three-position levers shall have nose extended, where required, to prevent cross-locking from being displaced.

(f) Locking dogs, trunnions and stops shall be riveted to bars.

(g) Locking faces shall fit squarely against each other with a minimum engagement, when locked, of at least three-fourths the designed locking face.

(h) Locking and connections must be so designed that when a lever or latch is mechanically locked, the following will be prevented:

1. Latch operated locking. Raising lever latch block so that bottom thereof is within $\frac{1}{4}$ in. of top of quadrant.

2. Lever moving in horizontal plane. Moving lever more than $\frac{1}{4}$ in. when in normal position or more than $\frac{1}{2}$ in. when in reverse position.

3. Lever moving in an arc. Moving lever more than 3 deg.

10. *Electric lever locks.*

(a) Locks shall be in accordance with Specification 99, Manual Part 96.

(b) Locks, with normally open circuit controllers, in addition to indication locks, shall be provided as specified by the Purchaser.

11. *Electric lever locking.*

(a) Levers used for the control of switches, derails, movable point frogs or apparatus that requires equivalent protective circuits shall be provided with:

1. A device to insure the locking of the units in a position corresponding to the position of the lever before the mechanical locking is released.

2. A device to prevent the movement of the lever from the normal or reverse position when the protecting track circuit is occupied.

3. A normally open latch circuit controller for electric locking circuits.

(b) Levers used for controlling signals shall be equipped with devices to prevent the release of the mechanical locking until the signals directly controlled are in normal position.

(c) Indication locks shall be arranged to check the movement of levers at the indicating points; lock plunger or latch shall be forced to locked position mechanically.

(d) Switch lever locks shall be arranged to lock the levers in the normal and reverse positions. Lock plungers shall be forced to the locked position mechanically for the normal and reverse positions.

12. *Time releases.*

(a) Time releases shall be installed as required by the Purchaser and shall be in accordance with Specification 128, Manual Part 129, where applicable.

(b) Setting of time releases shall be in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128. *R-12-b.

13. *Circuit controllers.*

(a) Circuit controllers shall be in accordance with Specification 138, Manual Part 197.

14. *Lever lights.*

(a) Lever lights shall be provided in the front of the machine immediately above or below the levers as specified by the Purchaser.

15. *Electric lamps.*

(a) Incandescent electric lamps shall be in accordance with Specification 51, Manual Part 91, and conform to Drawings 1541, 1542 and 1543.

16. *Binding posts.*

(a) Binding posts, nuts and washers for making connection leading from the machine to other signal equipment shall be provided and shall conform to Drawing 1070, assembly 107010.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(c) Supports for binding posts shall be of such material that wire connections will not loosen due to shrinkage.

(d) Binding posts for external wires shall, as far as practicable, be located adjacent to wire inlet, and duct spaces provided.

17. *Cases.*

(a) Machine shall be enclosed in a metal case which shall have removable covers and panels of convenient size to permit free access to all parts.

(b) Case shall be equipped for Purchaser's padlock. *R-17-b.

18. *Finish.*

(a) Metal parts shall be protected against corrosion except where such protection will interfere with the proper functioning of that part.

(b) Material used for protection against corrosion shall neither melt nor flake under atmospheric conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero.

* Alternate requisites section.

19. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

20. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(c) Coils adjacent to moving parts, armature air gaps or contacts shall be treated by impregnation or dipping with insulating varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

(d) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum wall thickness of $\frac{1}{16}$ in.

(e) Insulating material used for fillers in winding coils shall be chemically neutral.

(f) Coils shall be so insulated that they will withstand the insulation test provided in section 21. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

21. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for 1 minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for 1 minute an insulation test of 800 volts a.c.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for 1 minute an insulation test of 3,000 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit.

22. *Identification.*

(a) Magnet coils and resistors shall be plainly marked with Manufacturer's references.

23. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

24. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

25. *Packing.*

(a) Machine shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

26. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

27. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part

27. *Warranty.*—Continued.

or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-12-b.

Setting of time releases shall be

R-17-b.

Case shall be equipped for padlocks, cabinet locks.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 76-49—Electric Interlocking Machine,
Manual Part 85.

(Revision of A.A.R. Signal Section Specification 75-46)
A.A.R. SIGNAL SECTION SPECIFICATION 75-51.

MECHANICAL INTERLOCKING MACHINE, S. & F. LOCKING

1. *Purpose.*

(a) This specification is for the purpose of providing a mechanical interlocking machine, S. & F. locking, for the control of signals, switches, and other interlocking units. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Specifications and drawings.*

(a) Specifications and drawings referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Track and signal plan drawn to scale.
2. Designation of levers, working and spare, and spare lever spaces.
3. Sequence of numbering of levers.
4. Color for enamel finish.
5. Designation of lead-out, vertical or horizontal.
6. Designation of lever counterweights, if required.
7. Special features.
8. Inspection and tests as required.
9. Alternate requisites as required.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

6. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

7. *Design.*

(a) Machine shall be arranged for vertical lead-out or horizontal lead-out as specified by the Purchaser.

(b) Machine frame and locking bed shall be so designed that additional sections may be added on either end.

(c) Like parts of same Manufacturer's machine shall be interchangeable.

(d) Levers shall be numbered from left to right and arranged as specified by the Purchaser.

(e) Bolts, nuts and threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17.

(f) Tap bolt and cap screw heads shall be hexagonal.

(g) Bolts and cap screws, except for locking caps, shall be provided with spring lock washers where practicable.

(h) Machine legs, bottom girders, lever shoes, quadrants, top plates, rocker links, back, front and intermediate rails, end blocks, universal links, bearings, and strips, counterweights and locking brackets shall be made of cast iron.

(i) Link blocks, latch handles, latch nuts, drivers for end of locking shafts, locking shaft drivers for longitudinal locking bars, bottom girder caps and driving pieces for longitudinal locking bars, shall be made of malleable iron.

(j) Levers, tail levers, latch rods and locking bracket caps shall be made of open hearth steel.

(k) Locking shafts, longitudinal locking bars, cross-locking, dogs, stops, driving piece blocks and pins shall be made of cold-drawn steel.

(l) Machine shall consist of one, four or eight-lever sections.

(m) On machines having four or one-lever sections, the four-lever section shall be placed on the right-hand end of the machine; one-lever section may be placed on either end of the machine.

(n) Levers shall be spaced 5 in. center to center.

(o) Height of machine for vertical lead-out shall be 2 ft. 8 $\frac{1}{8}$ in. from bottom of leg to finished top of top plate.

(p) Height of machine for horizontal lead-out shall be 3 ft. 5 $\frac{7}{8}$ in. from bottom of leg to finished top of top plate.

(q) Each spare space shall be equipped with cap and pin for lever shoe.

(r) Taper dowel pins shall be tapered $\frac{1}{4}$ in. per ft. and 2 inches in length.

(s) Straight and taper dowel pins shall be of cold-drawn steel.

(t) When necessary to hold parts in fixed relation to each other, dowel pins or body-bound bolts, or both, shall be used.

(u) Movable parts of machine shall work freely, without lost motion.

(v) Parts of machine shipped knocked-down shall be marked with indented figures on a finished surface and given the numbers they take in the assembled machine. Numbers shall be visible in the assembled machine where practicable.

7. *Design.*—Continued.

(w) Locking brackets, cross-locking and swing dogs shall be marked to permit reading from back of machine. Longitudinal bars shall be marked on top on both ends from back of machine for space number. Riveted dogs shall be marked on top with lever number. Cross-locking shall be marked on top with bracket number in center and number of longitudinal bars between which cross-locking extends at the ends. Swing dogs shall be marked with bracket number at the trunnion end and lever number at the nose end.

(x) Legs for vertical lead-out machine shall be 2 ft. $7\frac{1}{4}$ inches in height and base of leg shall be provided with four holes for $\frac{3}{4}$ in. bolts.

(y) Legs for horizontal lead-out machine shall be 3 ft. 5 inches in height and base of leg shall be provided with four holes for $\frac{3}{4}$ in. bolts.

(z) Each end of bottom girder shall be fastened to machine legs with $\frac{3}{4}$ in. thin square-head body-bound bolts.

(aa) Caps shall be fastened to bottom girders with two $\frac{1}{2}$ in. hex-head machine bolts.

(bb) Top plates shall be fastened to machine legs with six $\frac{1}{2}$ in. T-head bolts, one $\frac{1}{2}$ in. cap screw and four No. 8 taper dowel pins.

(cc) End plates shall be fastened to top plates with two $\frac{1}{2}$ in. T-head bolts.

(dd) Latch block lift, to permit operation of lever, shall be not less than $\frac{3}{4}$ in.

8. *Levers.*

(a) Levers shall have equal and uniform throw and shall be true in alignment.

(b) Levers shall be so arranged that they can be removed without interfering with the operation of other levers.

(c) Levers shall be designed to latch in normal and reverse positions.

(d) Spare levers shall be furnished in place complete.

(e) Levers shall be equipped with counterweights as specified by the Purchaser.

(f) Levers shall be 5 ft. $10\frac{1}{8}$ in. from center of fulcrum to end of handle.

(g) Tail levers shall be drilled to provide $8\frac{3}{4}$ in. stroke, $9\frac{3}{4}$ in. stroke and $10\frac{3}{4}$ in. stroke, and shall be interchangeable as front or back tail levers.

(h) Lever shoes for vertical lead-out machine shall provide approximately equal stroke above and below the horizontal and be so arranged that connection may be made to front or back tail lever.

(i) Levers and tail levers for vertical lead-out machine shall fit snugly into lever shoe and be fastened thereto with two $\frac{3}{4}$ in. body-bound bolts.

8. *Levers.*—Continued.

(j) Levers for horizontal lead-out machine shall be fastened to lever shoe with three $\frac{5}{8}$ in. body-bound bolts and one No. 8 taper dowel pin.

(k) Lever shoe pins shall be 1 inch in diameter. End pins shall be held in place by one $\frac{3}{8}$ in. square-head cupped point set screw through girder cap.

(l) Quadrants shall be fastened to top plates with three $\frac{1}{2}$ in. bolts.

(m) Rocker links shall be fastened to quadrants with one 1 in. diameter grooved pin, pin to be held in place in quadrant with one $\frac{3}{8}$ in. by $\frac{5}{8}$ in. cone point headless set screw.

(n) Latch shoes, latch rods, nuts and latch springs shall be in accordance with Manufacturer's standards.

(o) Latch handles shall be 12 in. from center of hole to end of handle and shall be connected to lever and latch rod with one $\frac{1}{2}$ in. round cheese-head pin.

(p) Number plates shall be fastened to levers with one $\frac{1}{2}$ in. round cheese-head pin.

(q) Universal links shall be $5\frac{3}{4}$ in. center to center and connected to rocker links with one 1 in. flat swivel pin and one $\frac{1}{2}$ in. round cheese-head pin.

(r) Link blocks shall be 1 in. by $1\frac{1}{2}$ in. by $1\frac{1}{8}$ in. with a sliding fit, shall have lip $\frac{5}{16}$ in. thick and be not less than $\frac{5}{16}$ in. high.

9. *Locking.*

(a) Machine shall be provided with mechanical locking of the preliminary type.

(b) Locking bed shall be of ample size to accommodate future locking for spare levers and spaces.

(c) Locking shall be distributed as uniformly as possible without crowding and so arranged as to be accessible.

(d) Machine shall be fully equipped with cross-locking, brackets and bars, and locking shafts with drivers.

(e) Bearings for front, back and intermediate rails shall be fastened to machine legs with four $\frac{1}{2}$ in. bolts and two No. 8 taper dowel pins.

(f) Bearings for machines having locking beds 24-way or wider shall be provided with adjustable supports.

(g) Front and back rails shall be interchangeable and fastened to bearing with $\frac{1}{2}$ in. cap screw and two straight dowel pins.

(h) Intermediate rails shall be wide enough to accommodate two standard locking brackets.

(i) Front, back and intermediate rails shall be provided with one-way caps, and caps shall be fastened to rails with two $\frac{3}{8}$ in. cap screws.

(j) End blocks shall be fastened to rails with one $\frac{1}{2}$ in. cap screw.

(k) Ends of locking shaft shall be square and have like dimensions.

9. *Locking.*—Continued.

(l) Drivers for end of locking shafts shall be open approximately $\frac{1}{8}$ inch in back and allow for tight clamping, to be fastened with one $\frac{1}{2}$ in. bolt through shaft and connected to universal link with one $\frac{1}{2}$ in. round cheese-head pin.

(m) Drivers for longitudinal locking bars shall be of the clamp type with filler blocks and fastened to locking shafts with one $\frac{5}{8}$ in. finished bolt and nut through block and end of driver; bolts shall be threaded through one side of driver.

(n) Eight and twelve-way locking brackets only shall be used.

(o) Locking brackets shall be machined out for longitudinal bars to a depth of $1\frac{37}{64}$ in. below finished top of bracket and shall be $1\frac{1}{16}$ in. wide, and for cross-locking bars to a depth of $2\frac{5}{32}$ in. by $4\frac{9}{64}$ in. wide. Two $\frac{13}{32}$ in. holes and one hole for one straight dowel pin shall be drilled with jig through each end of bracket and brackets shall be fastened to rails with four $\frac{3}{8}$ in. cap screws and two straight dowel pins.

(p) Longitudinal locking bars shall have $1\frac{3}{4}$ in. stroke; spare bars shall be provided with stops.

(q) Splices in longitudinal locking bars shall conform to Drawing 1586. Bars in smaller than 40-lever machine frame shall be without splice.

(r) Locking dogs, swing dogs and trunnions for swing dogs shall conform to Drawings 1599 and 1600.

(s) Locking dogs shall be fastened to the longitudinal bars with two $\frac{1}{4}$ in. fillister-head rivets and one straight dowel pin. Swing dog trunnions and driving pieces shall be fastened to longitudinal bar with two $\frac{1}{4}$ in. fillister-head rivets. *R-9-s.

(t) Locking faces shall fit squarely against each other with a minimum engagement, when locked, of at least three-fourths the designed locking face.

(u) Latch blocks in locked combinations shall not have a lift of more than $\frac{1}{16}$ in., due to operating tolerance, and when locked shall not have more than $\frac{1}{8}$ in. total lift for direct locking between levers and an additional lift of not more than $\frac{1}{64}$ in. for each special in the combination. In no case shall the total lift exceed $\frac{1}{4}$ in.

10. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

11. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

* Alternate requisites section.

11. *Inspection.*—Continued.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

12. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

13. *Packing.*

(a) Machine shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

14. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

15. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-9-s.

Lockings dogs shall be fastened to the longitudinal bars with two $\frac{1}{4}$ in. fillister-head screws and one straight dowel pin. Swing dog trunnions and driving pieces shall be fastened to longitudinal bar with two $\frac{1}{4}$ in. fillister-head screws.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 75-46—Mechanical Interlocking Machine, S. & F. Locking, Manual Part 82.

A.A.R. SIGNAL SECTION SPECIFICATION 114-46.

MECHANICAL INTERLOCKING MACHINE, STYLE "A" LOCKING

As this type of machine is obsolete and no longer recommended for new installations or replacements it should be removed from the Manual.

Action Recommended

Acceptance for submission to letter ballot for removal from the Manual.
(Manual Part 83.)

(Revision of Requisites for Mechanically Locking the Levers of Interlocking Machines)
A.A.R. SIGNAL SECTION REQUISITES.

MECHANICALLY LOCKING THE LEVERS OF INTERLOCKING MACHINES

1951

1. *Purpose.*

(a) These requisites are for the purpose of setting forth the recommended general requirements for mechanically locking the levers of interlocking machines.

2. *Derail or smashboard.*

(a) Locking shall be provided between levers operating derails in conflicting routes. Each derail lever shall lock levers operating trailing point switches in the route except those held by locking between switch or signal levers.

(b) Derail or smashboard levers shall lock levers controlling movable bridge locking devices in reverse position, and shall lock bridge-operating machinery so as to be inoperative.

3. *Switch and movable point frog.*

(a) Switch lever locking provided shall not interfere with flexibility of train operation or prevent releasing of route when electric switch locking is used.

4. *Facing point lock.*

(a) Levers operating facing point locks that lock switches only shall lock the switch levers in normal and reverse positions.

(b) Levers operating facing point locks that lock switches and derails in combination shall lock the switch and derail levers in normal and reverse positions.

(c) Levers operating facing point locks that lock derails only shall lock the derail levers in reverse position.

5. *Signal.*

(a) Signal lever for the route shall lock smashboard levers in reverse position, facing point lock levers in reverse position (except those locked by switch or derail levers), switch levers in proper position (except when so locked by facing point lock levers), and conflicting derail and signal levers in the normal position when not otherwise so locked.

(b) When local conditions require, where switches for diverging moves and main track derails are located in close proximity to and are in the route approaching a signal, the signal lever shall lock these switch and derail levers in the position insuring that these switches and derails are set properly for the route leading to the signal.

5. *Signal.*—Continued.

(c) Mechanical or electric locking or electric circuits shall be installed to prevent signals from displaying aspects which permit conflicting movements except that opposing signals may display an aspect indicating proceed at restricted speed at the same time on a track used for switching movements only, by one train at a time.

(d) Where a separate approach signal lever is used, it shall lock the home signal lever in reverse position.

6. *Traffic or route.*

(a) Interlocking machine traffic or route lever controlling movements within or between interlockings shall be locked. Where practicable, the position of the traffic lever shall correspond to the direction in which traffic is established.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded

Requisites for Mechanically Locking the Levers of
Interlocking Machines, Manual Part 99.

(Revision of A.A.R. Signal Section Specification 198-46)
A.A.R. SIGNAL SECTION SPECIFICATION 198-51.

ELECTRIC SWITCH LOCKS

1. *Purpose.*

(a) This specification is for the purpose of providing electric locks for first and second voltage ranges for application to track switches. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Requisites, specifications and drawings.*

(a) Requisites, specifications and drawings referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Details of application.
2. Circuit characteristics for operation of lock, including voltage, amperes and frequency requirements.
3. Designation of special contact openings.
4. Designation of contact circuit load.
5. Designation of contact arrangement for opening and closing.
6. Special features.
7. Inspection and tests as required.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Lock is to be applied as specified by the Purchaser.

(b) Lock shall be designed for operation as specified by the Purchaser.

(c) Lock shall operate satisfactorily when the voltage is reduced to 80 per cent of rated voltage at 68 deg. F.

(d) Lock shall be enclosed in a substantial metallic weather-proof case, the door or covering of which shall be equipped with suitable fastening for application of Purchaser's padlock and when open shall permit access to all parts.

6. *Design.*—Continued.

(e) Mechanism shall be so constructed that any part may be readily removed.

(f) Provision shall be made for proper and convenient lubrication of mechanism.

(g) Wire entrance shall be of ample size, conveniently located for access to binding posts, and arranged to protect wires from mechanical injury.

(h) Like parts of same Manufacturer's apparatus shall be interchangeable.

(i) Lock shall be designed to prevent improper operation, due to vibration or external force applied to the connections or case.

(j) Lock shall be of the forced-drop type.

(k) Armature shall be equipped with a contact which checks its de-energized position.

(l) Bolts, nuts and threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17.

(m) Bolts and screws shall be provided with lock washers where practicable.

(n) Binding posts shall be spaced not less than 1 in. centers.

(o) Minimum air space of $\frac{1}{8}$ in. shall be provided between non-insulated current-carrying parts and other metallic parts.

(p) Locks shall have sufficient clearance between fixed and movable parts to insure free movement.

(q) Armature end play shall be not less than 0.010 nor more than 0.020 inch in d.c. lock, and not less than 0.030 nor more than 0.035 inch in a.c. lock.

(r) Trunnions shall be of such material as to withstand excessive wear due to vibration.

7. *Coils.*

(a) Coils shall be so made that they may be replaced without changing the magnetic and mechanical adjustment. When in place the coils shall be secured to prevent their movement by vibration.

(b) Connecting terminals of coils shall be joined either by a 14-24 or 10-32 binding post. Terminal leads of coils shall be of strands of tinned copper not larger than No. 28 A.W.G. wire. The aggregate cross-section of the strands shall at least equal that of a No. 18 A.W.G. wire. Leads shall be soldered to coil terminal wires with corrosion-resisting flux and shall be so insulated that they will withstand the insulation test provided in section 13.

(c) Coil terminal wires from the ends of the coils closest to the cores shall be used as lead wires.

(d) Coils shall be protected in a suitable manner from mechanical injury.

(e) At 68 deg. F., the percentage of variation in the resistance of individual coils shall not exceed:

1. For 5 ohms or less, plus or minus 5 per cent.
2. Above 5 ohms, plus or minus 10 per cent.

7. *Coils.*—Continued.

(f) Each coil shall be plainly and permanently marked, showing the Manufacturer's reference, nominal resistance, number of turns, size of wire and kind of wire insulation on a tag of non-conductive material adjacent to the outside lead.

(g) All coils shall be full wound and the number of turns shall not be permitted to vary more than 5 per cent, plus or minus, for any given coil. If a resistance above 5 ohms is specified which cannot be obtained with standard A.W.G. wire, using full-wound coils, the Manufacturer may furnish the nearest resistance to this value, using full-wound coils with standard A.W.G. wire.

8. *Contacts.*

(a) Contacts shall be made of suitable metal of sufficient mechanical strength.

(b) Material used in affixing contact elements shall not cause corrosion.

(c) Finger contacts shall meet contact surfaces squarely and simultaneously.

(d) Fingers shall have a slide movement of not less than 0.010 in. against contact surface.

(e) Contact opening shall be not less than 0.050 in.

9. *Finish.*

(a) Metal parts shall be protected against corrosion except where such protection will interfere with the proper functioning of that part.

(b) Material used for protection against corrosion shall neither melt nor flake under atmospheric conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero.

10. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

11. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

12. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

12. *Coil insulation.*—Continued.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(c) Coils adjacent to moving parts, armature air gaps or contacts shall be treated by impregnation or dipping with insulating varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

(d) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum wall thickness of $\frac{1}{16}$ in.

(e) Insulating material used for fillers in winding coils shall be chemically neutral.

(f) Coils shall be so insulated that they will withstand the insulation test provided in section 13. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

13. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for 1 minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for 1 minute an insulation test of 3,000 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit.

14. *Identification.*

(a) Locks shall be plainly marked with Manufacturer's references.

15. *Inspection.*

(a) The product furnished under this specification may be accepted upon Manufacturer's certificates of guarantee insuring that it is in accordance with the specification. If on arrival at destination the product is found not to meet the requirements of the specification it may be rejected and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

16. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

17. *Packing.*

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

18. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

19. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 198-46—Electric Switch Locks,
Manual Part 109,

PLANS FOR SWITCHES, FROGS, CROSSINGS, SPRING AND
SLIP SWITCHES, COLLABORATING WITH A.R.E.A.
COMMITTEE 5—TRACK

The spacing of ties shown on typical plans for interlocked and spring switch layouts, A.A.R. Signal Section 1948 Proceedings, Vol. XLVI, pp. 141 and 520, which was officially approved at the A.R.E.A. Annual Meeting in Chicago, Ill., on March 17, 1950, permits the application of any known types of rods and adjustment brackets in common use without redrilling. The A.R.E.A. track work plans have been revised accordingly. For hand-throw switches, the first tie under the switch is centered 3 inches back from the points and the No. 1 rod is located 12 inches from the points. For interlocked and spring switches, the first tie under the switch is centered $4\frac{1}{2}$ inches back from the points and the No. 1 rod is located 17 inches from the points. In each case the point drilling is $1\frac{1}{2}$ ", 5", 3", 5", 5".

In revising the A.R.E.A. track work plans, several widely used details on which the patents have expired, and other improvements, have been included, as follows:

1. All the radii and two of the lengths of curved split switches provide a better balance between the switch curvature and the lead curvature so that the deflection through the switch will not be the limiting factor in calculating by existing formulas, the permissible turnout speeds, and effect in several of the turnouts a considerable decrease in length.
2. A minimum tie spacing of $19\frac{1}{2}$ inches is provided for all split switches to permit more thorough tamping of ties. The plans show the tie layout for interlocked and spring switches requested by the Signal Section, A.A.R.
3. The inverted "V" type of switch point, known generally by the trade-name "Samson," is recommended for the turnout point in curved switches and is presented as an alternate for straight switch points. An undercut stock rail is specified for these switch points.
4. Uniform horizontal hole locations (except joint drilling) in all split switch lengths are provided for economy in production and to permit the application of roller bearings without redrilling at locations requested by the Signal Section, A.A.R. For rails over 110 pounds, the vertical distance from the base of the switch rail to the center of the rod clip holes is increased to $2\frac{7}{8}$ inches to improve the vertical stability of the switch point.
5. The hook design of twin tie plate is substituted for the plain flat design to provide a more positive shoulder against the rail base. The plans for graduated riser switches and all frog plans are affected by this substitution.
6. The plan for rail bound manganese steel frogs shows an improved construction at the flare blocks and permits the use of straight unattached ribs in the castings.

The following revised plans were adopted as recommended practice at the A.R.E.A. Annual Meeting in Chicago, Ill., on March 14, 1951, for publication in the Portfolio of Track Work Plans:

Plan 111-51 16' 6" Straight Split Switch with Uniform Risers.

- Plan 112-51 16' 6" Straight Split Switch with Graduated Risers.
Plan 113-51 11' 0" Straight Split Switch with Uniform Risers.
Plan 114-51 11' 0" Straight Split Switch with Graduated Risers.
Plan 115-51 22' 0" Straight Split Switch with Uniform Risers.
Plan 116-51 22' 0" Straight Split Switch with Graduated Risers.
Plan 117-51 30' 0" Straight Split Switch with Uniform Risers.
Plan 118-51 30' 0" Straight Split Switch with Graduated Risers.
Plan 121-51 13' 0" Curved Split Switch with Uniform Risers.
Plan 122-51 13' 0" Curved Split Switch with Graduated Risers.
Plan 123-51 19' 6" Curved Split Switch with Uniform Risers.
Plan 124-51 19' 6" Curved Split Switch with Graduated Risers.
Plan 125-51 26' 0" Curved Split Switch with Uniform Risers.
Plan 126-51 26' 0" Curved Split Switch with Graduated Risers.
Plan 127-51 39' 0" Curved Split Switch with Uniform Risers.
Plan 128-51 39' 0" Curved Split Switch with Graduated Risers.
Plan 181-51 Spring Switches.
Plan 209-51 Numerical and Classified Index of Detail
Numbers Covering Switch Equipment.
Plan 221-51 Details for Switch Points.
Plan 222-51 Switch Rods and Clips.
Plan 241-51 Details and Typical Applications of Hook Twin Tie Plates.
*Plan 322-51 No. 4, No. 5 and No. 6 Bolted Rigid Frogs.
*Plan 323-51 No. 7, No. 8 and No. 9 Bolted Rigid Frogs.
*Plan 324-51 No. 10, No. 11 and No. 12 Bolted Rigid Frogs.
*Plan 401-51 No. 10 Spring Rail Frog.
*Plan 405-51 No. 10 Spring Rail Frog—Short Spring Rail Type.
*Plan 407-51 No. 9, No. 11 and No. 12 Spring Rail Frogs.
*Plan 408-51 No. 9, No. 11 and No. 12 Spring Rail Frogs—Short Spring
Rail Type.
Plan 600-51 Data and Sections for Rail Bound Manganese Steel Frogs.
*Plan 611-51 No. 4 and No. 5 Rail Bound Manganese Steel Frogs.
*Plan 612-51 No. 6, No. 7 and No. 8 Rail Bound Manganese Steel Frogs.
*Plan 613-51 No. 9, No. 10 and No. 11 Rail Bound Manganese Steel Frogs.
*Plan 614-51 No. 12, No. 14 and No. 15 Rail Bound Manganese Steel Frogs.
*Plan 615-51 No. 16, No. 18 and No. 20 Rail Bound Manganese Steel Frogs.
*Plan 622-51 No. 6, No. 7 and No. 8 Rail Bound Manganese Steel Frogs for
Rails 112 pounds and Heavier.
*Plan 623-51 No. 9, No. 10 and No. 11 Rail Bound Manganese Steel Frogs for
Rails 112 pounds and Heavier.
*Plan 624-51 No. 12, No. 14 and No. 15 Rail Bound Manganese Steel Frogs
for Rails 112 pounds and Heavier.
*Plan 625-51 No. 16, No. 18 and No. 20 Rail Bound Manganese Steel Frogs
for Rails 112 pounds and Heavier.
Plan 768-51 Manganese Steel Insert Crossings Angles 14° 10' to 8° 10' for
Rails Less Than 6" in Height.

Action Recommended
Acceptance as information.

* The revisions on these plans consist only in the tables thereon showing the quantities of hook twin tie plates to be furnished.

APPLICATION OF ROLLER BEARINGS TO A.R.E.A. INTERLOCKED
AND SPRING SWITCH LAYOUT PLANS

In A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 66-A and 357-A, Committee II presented a report on Use of Roller Bearings on Interlocked and Spring Switches, showing the considerable use of roller bearings on the various railroads, together with results of tests, and listing the principal advantages of roller bearings.

In A.A.R. Signal Section 1948 Proceedings, Vol. XLVI, pp. 141 and 520, Committee II presented Typical Plans for Interlocked and Spring Switch Layouts, based on A.R.E.A. switch plans. These typical plans bear the note "Roller bearings may be used when desired."

There are two different types of roller bearings for switches in general use: one, the 57513-1 type, uses a single roller supported on the ties in the center of the track and a special form of switch rod which ordinarily either replaces an existing common switch rod or is similarly applied to existing unused holes in the switch point, such holes being specified on A.R.E.A. plans to permit application of additional common switch rods when desired. When applied to A.R.E.A. spring switches, however, this special roller bearing switch rod is required in tie spaces where no switch rod clip holes are now provided. A disengaging connection to the switch rails is necessary and the roller bearing cannot be placed in the same switch rod space as the disengaging rod.

The other roller bearing, Style R, requires independent rollers applied to each switch point. Since there is no tie bar across the switch as part of these bearings, it follows that they must be applied in tie spaces which do not have switch rods. To avoid unnecessary numbers of varieties of bearing bracket castings, this type bearing is supplied in two forms: one suitable for rails heavier than 110 pounds and the other for rail 110 pounds and lighter. This division corresponds with that now employed by the A.R.E.A. for certain switch details. Application of this type roller bearing to A.R.E.A. switches requires one bolt through the stock rail and two bolts through the point on each side where holes are not now provided.

There is no particular problem in field drilling of the one hole in each stock rail, but drilling two holes through each hardened point and its two reinforcing bars is a relatively difficult proceeding. The holes provided for fastening the reinforcing bars to the switch points of A.R.E.A. switches unfortunately have not been located where holes are required for the application of these roller bearings. The field drilling of the point is particularly aggravating because it is obvious such operation would be unnecessary if the holes for fastening the reinforcing bar were rearranged to suit the roller bearings.

Collaboration with A.R.E.A. Committee 5—Track resulted in the revision of A.R.E.A. Switch Plans 111 to 118, inclusive, for straight switches; 121 to 128, inclusive, for curved switches, and 181 for spring switches, to show uniform horizontal hole locations (except joint drilling) in all switch lengths. For rails heavier than 110 pounds, all holes are to be drilled at a uniform vertical distance of $2\frac{7}{8}$ inches from the base of the switch rail and uniformly drilled for 1 inch bolt. The arrangement is satisfactory for application of 57513-1 type roller

bearings. The manufacturer of the Style R roller bearing has agreed to modify the pattern for the bracket used with rails heavier than 110 pounds so that new production will be applicable to present $\frac{7}{8}$ inch bolts at $3\frac{1}{4}$ inch elevation and proposed 1 inch bolts at $2\frac{7}{8}$ inch elevation.

The revised A.R.E.A. plans permit the application of roller bearings without redrilling at locations requested by the Signal Section, A.A.R. The plans were adopted as recommended practice at the A.R.E.A. Annual Meeting in Chicago, Ill., on March 14, 1951, for publication in the Portfolio of Track Work Plans.

Action Recommended

Acceptance as information.

(Revision of A.A.R. Signal Section Specification 150-43)
A.A.R. SIGNAL SECTION SPECIFICATION 150-51.

CENTRALIZED TRAFFIC CONTROL MACHINE

1. *Purpose.*

(a) This specification is for the purpose of providing a machine for the control of signals, switches and other apparatus of a centralized traffic control system. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Requisites, specifications and drawings.*

(a) Requisites, specifications and drawings referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Track and signal plan drawn to scale.
2. Plan showing tracks, signals, and indicator lights to be included on track chart.
3. Designation of levers, working and spare, and spare lever spaces.
4. Control panel, traingraph and desk designation.
5. Indicator lights other than for track layout.
6. Color for enamel finish.
7. Special features including circuit controllers.
8. Inspection and tests as required.
9. Alternate requisites as required.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

6. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

7. *Design.*

- (a) Machine shall include the following features:
 - 1. Switch, signal, traffic and other levers as required.
 - 2. Controllers.
 - (a) For establishing stick or non-stick control of signals. *R-7-a-2-a.
 - (b) For special purposes as required by Purchaser.
 - 3. Lights for indicating the position of the controlled apparatus.
 - 4. Track diagram with indicator lights.
 - 5. Power off and on shall be indicated by lights on machine. *R-7-a-5.
 - 6. Maintainers' call.
 - 7. Control panel, traingraph and desk illumination as specified by Purchaser.
 - 8. Traingraph for automatically creating a time chart record of all train movements over the controlled territory. *R-7-a-8.
 - 9. Visual or audible indication, or both, for OS reporting.
 - 10. Auxiliary line transfer. *R-7-a-10.
 - 11. Means for cutting out faulty stations.
- (b) Like parts of same Manufacturer's machine shall be interchangeable.
- (c) Moving parts of machine shall work freely and without excessive lost motion.
- (d) Bolts, nuts and threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17.

8. *Levers.*

- (a) Switches and signals shall not be controlled from the same lever. *R-8-a.
- (b) Levers of like character shall have equal and uniform throw and shall be true in alignment.
- (c) Levers shall be so arranged that they may be removed without interfering with the operation of other levers.

9. *Relays.*

- (a) Relays used as communication apparatus for transmission of controls and indications shall be in accordance with Specification 180, Manual Part 145, or Specification 224, Manual Part 228.

10. *Circuit controllers.*

- (a) Contact members shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.
- (b) The movement of the contact members shall be such as will insure a wiping contact.

* Alternate requisites section.

11. *Binding posts.*

(a) Binding posts, nuts and washers for field wire connections shall conform to Drawing 1070, assembly 107010.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, 107010, 107020, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than $\frac{7}{8}$ in. centers.

(e) Supports for binding posts shall be of such material that wire connections will not loosen due to shrinkage.

12. *Light indicators.*

(a) Lever indicators shall be located in front of machine immediately below, above or in the levers. *R-12-a.

(b) Track indicators shall be located on the track diagram. *R-12-b.

13. *Electric lamps.*

(a) Incandescent electric lamps shall be in accordance with Specification 51, Manual Part 91, and conform to Drawings 1541, 1542 and 1543.

14. *Tools.*

(a) Special tools required for the maintenance of the machine shall be furnished by the Contractor. *R-14-a.

15. *Case.*

(a) Machine shall be enclosed in a metal case which shall have removable covers or panels, or both, of convenient size to permit free access to all parts.

(b) Case shall be equipped with cabinet lock. *R-15-b.

16. *Finish.*

(a) Metal parts shall be protected against corrosion except where such protection will interfere with the proper functioning of that part.

(b) Material used for protection against corrosion shall neither soften nor flake under atmospheric conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero.

17. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110,

* Alternate requisites section.

(Revision of Requisites for Automatic Block Signaling Circuits)
A.A.R. SIGNAL SECTION REQUISITES.

AUTOMATIC BLOCK SIGNALING CIRCUITS

1951

1. *Purpose.*

(a) These requisites are for the purpose of setting forth the recommended general requirements for automatic block signaling circuits.

2. *General.*

(a) Automatic block signal circuits may be coded and operated by:

1. Direct current.
2. Alternating current.
3. Rectified alternating current.
4. Coded direct current.
5. Coded alternating current.
6. Coded rectified alternating current.

3. *Track circuits.*

(a) Track circuits shall be in accordance with Requisites for Track Circuits, Manual Part

4. *Signal operating circuits.*

(a) Both sides of the 45 and 90 deg. semaphore signal hold clear circuits, and at least one side of the motor circuit, shall be controlled through the contacts of the "H" relay or relays, or through the neutral contacts of the polar "HD" relay, and in addition one side of the 90 deg. hold clear and motor circuits shall be controlled through the contact of the "D" relay or the equivalent polar contact of the "HD" relay.

(b) One side of the lamp circuit of a light signal giving indications by control of lamp circuits shall be controlled through the neutral contacts of the "H" relay or relays. The lamp circuit of the proceed indication shall, in addition, be controlled through the "D" relay or equivalent contact of the polar "HD" relay.

(c) Both sides of local operating circuit of searchlight type signal shall be controlled through contacts of the "H", "D," or "HD" relay, where used.

(d) The circuit shall be so designed that:

1. The failure of any part of the circuit controlling the indication intended to be displayed shall not cause the signal to display a more favorable indication.

2. The failure of a lamp in a light signal or a semaphore signal arm assuming a false restrictive position shall not cause the signal to display a more favorable indication than intended.

18. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(c) Coils adjacent to moving parts, armature air gaps or contacts shall be treated by impregnation or dipping with insulating varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

(d) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum wall thickness of $\frac{1}{16}$ in.

(e) Insulating material used for fillers in winding coils shall be chemically neutral.

(f) Coils shall be so insulated that they will withstand the insulation test provided in section 19. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

19. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for 1 minute an insulation test, at place of manufacture, of 1,500 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for 1 minute an insulation test of 800 volts a.c.

(b) A surface leakage distance of not less than $\frac{1}{8}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for 1 minute an insulation test of 1,500 volts a.c. between their terminals.

20. *Identification.*

(a) Magnet coils and resistors shall be plainly marked with Manufacturer's references.

11. *Binding posts.*

(a) Binding posts, nuts and washers for field wire connections shall conform to Drawing 1070, assembly 107010.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, 107010, 107020, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than $\frac{7}{8}$ in. centers.

(e) Supports for binding posts shall be of such material that wire connections will not loosen due to shrinkage.

12. *Light indicators.*

(a) Lever indicators shall be located in front of machine immediately below, above or in the levers. *R-12-a.

(b) Track indicators shall be located on the track diagram. *R-12-b.

13. *Electric lamps.*

(a) Incandescent electric lamps shall be in accordance with Specification 51, Manual Part 91, and conform to Drawings 1541, 1542 and 1543.

14. *Tools.*

(a) Special tools required for the maintenance of the machine shall be furnished by the Contractor. *R-14-a.

15. *Case.*

(a) Machine shall be enclosed in a metal case which shall have removable covers or panels, or both, of convenient size to permit free access to all parts.

(b) Case shall be equipped with cabinet lock. *R-15-b.

16. *Finish.*

(a) Metal parts shall be protected against corrosion except where such protection will interfere with the proper functioning of that part.

(b) Material used for protection against corrosion shall neither soften nor flake under atmospheric conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero.

17. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

* Alternate requisites section.

21. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

22. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

23. *Packing.*

(a) Machine shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

24. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

25. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-7-a-2-a.

Machine shall not include controllers for establishing stick or non-stick control of signals.

R-7-a-5.

Power off and on shall not be indicated by lights on machine.

R-7-a-8.

Traingraph shall not be provided.

R-7-a-10.

Auxiliary line transfer shall not be provided.

R-8-a.

Switches and signals may be controlled from the same lever.

R-12-a.

Lever indicators shall be located

R-12-b.

Track indicators shall be located

R-14-a.

Special tools required for the maintenance of the machine shall be furnished by the Purchaser.

R-15-b.

Case shall be arranged for Purchaser's padlocks.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 150-43—Centralized Traffic Control Machine,
Manual Part 98.

(Revision of A.A.R. Signal Section Specification 101-50)
A.A.R. SIGNAL SECTION SPECIFICATION 101-51.

ELECTRIC MOTOR SWITCH OPERATING MECHANISM

Proposed Revision

6. *Design and functional requirements.*

(d) Mechanism.

2. Mechanism and case shall be so arranged that lock rod may be readily removed. Ends of plunger or locking dogs and holes or notches in lock rod shall have square edges and shall extend through lock rod $\frac{3}{4}$ in. or more in either normal or reverse position. Such holes or notches shall be not more than $\frac{1}{8}$ in. wider than the plunger.

8. Point detector feature shall be dependent upon and follow the movement of the switch point, and shall be so designed that the connection to the switch point can be so adjusted that the circuit controller contacts will be prevented from assuming the positions indicating point closure if the switch point is prevented by an obstruction from closing to within $\frac{1}{4}$ in.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 6-d-2 and 6-d-8 of Specification 101-50—Electric Motor Switch Operating Mechanism, Manual Part 104.

(Revision of A.A.R. Signal Section Specification 138-44)
A.A.R. SIGNAL SECTION SPECIFICATION 138-51.

MECHANICALLY OPERATED CIRCUIT CONTROLLER FOR INTERLOCKING MACHINE LEVER

1. *Purpose.*

(a) This specification is for the purpose of providing circuit controllers actuated by electric, electro-mechanical, or mechanical interlocking machine lever. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Specifications and drawings.*

(a) Specifications and drawings referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Purchaser's drawings.
2. Designation of special contact openings.
3. Designation of contact circuit load.
4. Designation of contact arrangement for opening and closing.
5. Special features.
6. Inspection and tests as required.
7. Alternate requisites as required.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

6. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

7. *Design.*

(a) Controller not protected by the interlocking machine case shall be enclosed in a separate substantial metallic case for each controller, the door or covering of which when open shall provide access to all parts.

7. *Design.*—Continued.

(b) The door or covering shall be equipped with suitable fastening for application of Purchaser's padlock. *R-7-b.

(c) Mechanism shall be so constructed that any part may be readily removed.

(d) Provision shall be made for convenient lubrication.

(e) Wire entrance shall be of ample size, conveniently located for access to binding posts, and arranged to protect wires from mechanical injury.

(f) Like parts of same Manufacturer's apparatus shall be interchangeable.

(g) Controller shall be designed to prevent improper operation, due to vibration or external force applied to the connections or case.

(h) Operating connection between lever and controller, shall be so designed that if it is not enclosed in locked or sealed case it cannot be disconnected without removing a seal. *R-7-h.

(i) Bolts, nuts and threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17.

(j) Bolts and screws shall be provided with lock washers, where practicable.

(k) Nuts, bolt and cap screw heads shall be hexagonal.

(l) Minimum air space of $\frac{1}{4}$ in. shall be provided between non-insulated current-carrying parts and other metallic parts.

(m) Controllers shall have sufficient clearance between fixed and movable parts to insure free movement.

(n) Contact members and fastenings shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.

(o) Movement of the contact members shall be such as will insure a wiping contact.

(p) Contacts shall be so secured that they will not shift nor become loose in service.

8. *Binding posts.*

(a) Binding posts, nuts and washers for field wire connections shall conform to Drawing 1070, assembly 107010. *R-8-a.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, 107010, 107020, or soldered terminals, shall be used where no field wires are connected to such terminals. *R-8-b.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Supports for binding posts shall be of such material that wire connections will not loosen due to shrinkage.

* Alternate requisites section.

9. *Finish.*

(a) Metal parts shall be protected against corrosion except where such protection will interfere with the proper functioning of that part.

(b) Material used for protection against corrosion shall neither melt nor flake under atmospheric conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero.

10. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

11. *Insulation.*

(a) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions.

12. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for 1 minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

13. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

14. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

15. *Packing.*

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

16. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

17. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-7-a.

Door or covering shall be equipped with suitable fastening
for { seal. }
{ }

R-7-h.

Operating connection between lever and controller shall be so designed that it cannot be disconnected without removing.....
.....
.....

R-8-a.

Binding posts, nuts and washers for field wire connections shall conform to Manufacturer's standard.

R-8-b.

Binding posts, nuts, washers and soldered terminals shall conform to Manufacturer's standard where no field wires are connected to such terminals.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 138-44—Interlocking Lever Circuit Controller,
Manual Part 197.

COMMITTEE III—SIGNAL SHOP PRACTICE

Personnel

E. S. Taylor, Chairman

P. P. Ash, Vice-Chairman

D. C. Bettison

H. V. Stone

E. R. Frachiseur

R. E. Testerman

J. E. Hillig

W. M. Vogts

J. G. Karlet

A. M. Weeks

W. Poole

J. F. Yerger

J. P. Stevely

E. H. Branson*

A. W. Fisher*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Recommend facilities and procedure for test and repair of relays.
2. Investigate and report on the factors involved in the establishment of repair facilities.

The Committee submits for consideration, reports on the following subjects**:

1. Facilities and procedure for test and repair of relays.
2. Factors to be considered in establishing a signal shop layout.

Disposition of 1950 Letter Ballot Subject

The following subject presented by Committee III at the 1950 Annual Meeting was submitted to letter ballot and officially approved:

Requisites for Containers for Shipping Relays and Similar Apparatus—Now in Manual Part 272.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

FACTORS TO BE CONSIDERED IN ESTABLISHING A
SIGNAL SHOP LAYOUT

In establishing a signal shop layout, it is necessary to consider a number of factors to determine the type of facilities required.

After a careful review of the facilities now in use in the signal shops of various railroads, it has been established that the following list represents the major items for which maintenance, repair and testing facilities should be considered in a signal shop layout:

1. Relays.
 - (a) D.C. conventional.
 - (b) A.C. conventional.
 - (c) Plug-in, code-responsive, code transmitter, traffic control.
 - (d) Searchlight signal units.
 - (e) Time releases, mechanical and electric.
 - (f) Switch and tower indicators.
2. Electric locks, including switch locks.
3. Rectifiers and dry type transformers.
4. Electric switch machines.
5. Electro-pneumatic switch machines.
6. Electro-pneumatic switch valves.
7. Electric switch machine controllers and switch circuit controllers.
8. Electric motor signal mechanisms including crossing gates.
9. Light type signals, including highway crossing signals, switch lamps, semaphore lamps, etc.
 - (a) Mechanical and electrical repairs.
 - (b) Optical check and adjustment.
10. Interlocking and control machines.
11. Impedance bonds and oil-cooled transformers.
12. Train control receivers, inductors, train stops, dragging equipment detectors, etc.
13. Drill bits. (Grinding of)
14. Bonding machines, air compressors.
15. Car retarder equipment.
16. Electronic and communication equipment.
17. Electric measuring instruments, repair and calibration.

Provisions for all the foregoing items are not necessarily a requirement for all railroads. In developing shops for the various railroads, the type of shop should be governed by the following:

When giving consideration to a signal shop layout, decision will have to be made by the railroad as to what extent repairs are to be undertaken. As a guide in reaching this decision, reference should be made to "Formula for Determining Cost of Repairing Signal Material" and "Salvaging or Repairing of Signal Material" appearing on pages 93-96, inclusive, of the 1950 Annual Meeting Advance Notice and discussion on same appearing on page 304 of the 1950 Annual Meeting Minutes (A.A.R. Signal Section 1949 Proceedings, Vol. XLVII).

On the assumption that the signal shop is to provide for the repair and adjustment of relays and related items, reference should be made to report entitled "Facilities and Procedure for Test and Repair of Relays," appearing on page 158 of this Advance Notice.

A repair shop, with relays as the predominant item, could be arranged to include repairs and tests on other items of a similar nature which can be repaired and tested with the same tools and equipment. For such an arrangement, consideration should be given to the following items:

1. Relays.
 - (a) D.C. conventional.
 - (b) A.C. conventional.
 - (c) Plug-in, code-responsive, code transmitter, traffic control.
 - (d) Searchlight signal units.
 - (e) Time releases, mechanical and electric.
 - (f) Switch and tower indicators.
2. Electric locks, including switch locks.
3. Rectifiers and dry type transformers.

If the shop is to be expanded to provide for repairing and testing of items other than those mentioned in the preceding paragraph, consideration should be given to providing space and facilities for the following:

4. Electric switch machines.
5. Electro-pneumatic switch machines.
6. Electro-pneumatic switch valves.
7. Electric switch machine controllers and switch circuit controllers.
8. Electric motor signal mechanisms including crossing gates.
9. Light type signals, including highway crossing signals, switch lamps, semaphore lamps, etc.
 - (a) Mechanical and electrical repairs.
 - (b) Optical check and adjustment.
10. Interlocking and control machines.
11. Impedance bonds and oil-cooled transformers.
12. Train control receivers, inductors, train stops, dragging equipment detectors, etc.
13. Grinding of bonding drill bits.
14. Bonding machines, air compressors.

Consideration should be given to providing separate facilities for the following:

15. The repair of car retarder equipment and associated devices should be considered separately as the repairs, in the majority of cases, can be more economically made at the retarder location. This is due to the weight of parts to be repaired and the shipping difficulties encountered.

The following items are dependent upon volume of work, also the possibility of obtaining the properly qualified help:

16. Electronic and communication equipment.
17. Electric measuring instruments, repair and calibration.

The following facilities should be considered dependent upon the volume and type of work on hand and in sight:

- Welding and blacksmith work.
- Painting.

In general, the shop layout should provide space for the following:

- (a) Supervisory, clerical force and records with the proper facilities. (Washroom, etc.)
- (b) Storage of parts, etc.
- (c) Preliminary inspection, dismantlement, cleaning facilities, repairing and calibration of relays.
- (d) Welding and blacksmith work.
- (e) Painting.
- (f) Testing.
- (g) Assembling and shipping.
- (h) Storage batteries and power supply.
- (i) Ventilation and lights.
- (j) Heating and plumbing facilities.
- (k) Compressed air supply.

This layout should be made in such a manner that the material will pass through the shop in an orderly fashion and require only the minimum amount of handling.

Action Recommended

Acceptance as information.

FACILITIES AND PROCEDURE FOR TEST AND
REPAIR OF RELAYS*Shop Practices*1. *Organization.*

(a) The size of the relay shop force to be used should be based on the work load. After the approximate number of relays to be handled has been established and the average time per relay has been determined, the force can be set up to take care of the requirements.

(b) The personnel should be trained in the testing and inspecting of relays.

(c) Instructions and specifications for repairing, adjusting and testing relays should be provided.

(d) Instructions should be provided on the method of determining which relays should be repaired. (See "Salvaging or Repairing of Signal Material," A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, p. 96.)

2. *Shop building.*

(a) Shop building should be of sufficient size to provide adequate work space for the force employed. Since most of the work involved is precision bench work, benches should be arranged at the most comfortable work height with adequate illumination provided. Too much light from overhead produces severe eye-strain. Where full-size windows are used, they should be properly shaded.

(b) Relay assembly room should be clean, well-lighted, and protected against dirt, dust and outside gases being drawn into the room.

(c) Final adjustment, calibration and inspection should be given special attention regarding cleanliness and lighting, preferably by the use of a separate room.

(d) Adequate heating, ventilation, washing and toilet facilities should be provided.

3. *Equipment.*

(a) The following equipment is considered essential:

1. High grade combination grinder and buffer, or separate machines.
2. High grade $\frac{1}{2}$ inch post drill.
3. Vats for cleaning solutions.
4. One-fourth inch portable electric drill.
5. Jigs designed to hold any size relay in vise.
6. Standard bench vises.
7. Clean dry air supply at each work bench with small hand blow gun.
8. Universal jig on swivel mounting to fit all type relays at each work bench.
9. Permanent magnet charger.
10. Demagnetizer (a.c.).
11. Fluxmeter.
12. Battery supply with charging equipment.
13. Insulation dielectric testing equipment.
14. Low range direct reading ohmmeter.

3. *Equipment.*—Continued.

15. High range direct reading ohmmeter.
16. Interval timing device.
17. Necessary voltmeters and ammeters, and special measuring equipment as required.
18. Hand tools, gages, etc., at each work bench.
19. Relay test panels with necessary a.c. and d.c. power supplies.
20. Fireproof storage for paints and inflammable liquids.
21. Drying oven or equivalent.
22. Benches, storage racks, bins, etc.

4. *Relay overhaul and calibration procedure.*

- Step 1. Receipt of relays at the shop.
Classification for repair or scrap. Questionable relays set to one side for further inspection.
- Step 2. Dismantling (when required).
Relays brought to work bench and dismantled as far as necessary for repairs. Component parts cleaned and treated as required for reuse.
- Step 3. Preliminary assembly.
Magnetic circuit parts checked for proper type. Mechanical check for air gap. Trunnion screws checked for wear and alignment. Assemble contacts. Nuts and washers installed on all except coil posts. Assemble coils loose on cores. Back straps or yokes and loose parts placed in base of relay and relay set aside for adjustment.
- Step 4. Adjustment.
Make further assembly as required for adjustment. Magnetic air gap, trunnion screws, and contacts checked and adjusted. Coils checked and assembled. Preliminary check of operating values and necessary adjustments to make relay meet specifications.
- Step 5. Inspection.
Make visual inspection of ribbons, contacts, air gaps, etc. Check all nuts and screws. Set relay aside for calibration.
- Step 6. Final calibration and record.
Make complete calibration test and record the values on inside of relay.
Complete the assembly of relay and recheck calibration.
Make dielectric check and seal relay.
Make records as instructed.
- Step 7. Shipment.
Relays should be shipped in approved shipping containers.

Note.—The foregoing recommendations are considered typical for conventional type d.c. and a.c. relays. Other relays such as plug-in, code-responsive, centralized traffic control, etc., would require slight alterations in the procedure and the addition of special testing equipment, but would otherwise follow the outline as indicated.

Action Recommended
Acceptance as information.

COMMITTEE IV—AUTOMATIC BLOCK SIGNALING

Personnel

E. N. Fox, Chairman	
L. B. Yarbrough, Vice-Chairman	
H. D. Abernethy	W. T. Lewis
C. M. Acker	P. H. Linderth
R. B. Amsden	H. A. Maynard
J. A. Beoddy	C. F. Nelson
L. S. Bottinelli	S. E. Noble
F. L. Chatten	M. A. Otterbourg
W. L. Dayton	D. H. Steiner
J. R. Heisler	H. G. Stiebeling
H. Jensen	R. E. Taylor
A. L. Jordan	W. G. Trost
T. H. Kearton	W. L. Waleen

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on protection against lightning.
4. Investigate and report on methods of improving shunting of track circuits.
5. Investigate and report on means and methods for the improvement of track circuit rail bonding used in signaling, collaborating with Committees I and V.
6. Investigate and report on the use of automatic block systems, with superimposed control.
7. Investigate and report on the use of track instruments instead of track circuits for the release of electric switch locks and electric locking.
8. Investigate and report on the use of high voltage lightning arresters—various voltage ranges.
9. Investigate and report on the practicability of in-service tests of all types of lightning arresters.
10. Investigate and report on devices for sanding of rail, or equivalent, which will reduce track circuit shunt failures due to sand, collaborating with Mechanical Division, A.A.R.
11. Investigate and report on the various types of power for operating signaling systems and the operating cost therefor.
12. Performance specification for solderless type connectors for use in wiring signal apparatus (various size conductors).
13. Investigate and report on the advisability of preparing a specification or requisites covering screw locks and signal padlocks for outside use.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification 135-50, Manual Part 22.
Requisites for Track Circuits.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

Revision of Requisites for Automatic Block Signaling Circuits, Manual Part 34.

Revision of Instructions for Minimizing the Effect of Foreign Current on Direct Current Track Circuits, Manual Part 127.

Revision of Requisites for Electric Locks Applied to Hand-Operated Switches for Protection of Main Track Movements, Manual Part 211.

Revision of Formulae for Computing Minimum Allowable Resistance between Track Battery and Track and for Computing Related Current and Voltage Data, Manual Part 132.

Revision of Specification 60-40, Manual Part 92.

Revision of Specification 52-43, Manual Part 95.

5. Test of machine application of rail head bonds.

Cooperative report. American Petroleum Institute Correlating Committee on Cathodic Protection.

Cooperative report. American Standards Association Sectional Committee on Preferred Voltages, 100 Volts and Under—Project C67.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

Disposition of 1950 Letter Ballot Subjects

The following subjects presented by Committee IV at the 1950 Annual Meeting were submitted to letter ballot and officially approved:

Specification 135-50—Track Circuit Bonding—Now in Manual Part 22.

Specification 151-50—Plug Type Rail Bonds and Track Circuit Connectors—Now in Manual Part 112.

A.A.R. Sig. Sec. 1047B—Welded Type Rail Head Bonds and Track Circuit Connectors—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1631E—Single Conductor Plug Type Rail Bonds and Track Circuit Connectors—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1632E—Duplex Conductor Plug Type Rail Bonds and Track Circuit Connectors—Now in Drawing Section of Manual.

Requisites for Track Welding or Heat Treating in Track Circuit Territory—Now in Manual Part 156 (as Instructions).

Requisites for Minimizing the Effect of Foreign Current on Direct Current Track Circuits—Now in Manual Part 127 (as Instructions).

Specification 199-50—Electric Motor Mechanism and Gate Arm for Highway Grade Crossing Signal—Now in Manual Part 194.

Specification 160-50—Capacitor for Power Factor Improvement—Now in Manual Part 100.

Specification 78-50—Alternating Current Induction Type Relay—Now in Manual Part 122.

Specification 162-50—Color Position Light Signal—Now in Manual Part 50.

Specification 157-50—Color Light Signal, Searchlight Type—Now in Manual Part 93.

(Revision of A.A.R. Signal Section Specification 135-50)
A.A.R. SIGNAL SECTION SPECIFICATION 135-51.

TRACK CIRCUIT BONDING

Proposed Revision

6. General.

(e) Cross connections at crossovers and turnouts for fouling protection shall consist of at least two conductors in multiple having a total resistance not exceeding 0.006 ohm and each shall be not smaller than No. 9 A.W.G. wire and of sufficient conductivity that the track relay will be in de-energized position when the circuit is shunted. Connections shall be so installed as to avoid breaks and in accordance with Form 7004, Manual Part 206.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Section 6-e of Specification 135-50—Track Circuit Bonding,
Manual Part 22.

TEST OF MACHINE APPLICATION OF RAIL HEAD BONDS

One manufacturer has recently developed and is marketing a hydraulic bond driver for applying rail head type bonds. The machine used in this test was factory adjusted for 12,000 pounds pressure. The pressure could be increased or decreased by changing the relief valve for one designed to produce a different pressure.

To clear up any question as to whether machine application was superior to hand application as to holding power, tests were conducted on a Member Road. The tests were not conducted to determine any preference to any particular bond but solely to determine the results of machine application compared to hand drive.

Four different types of bonds were used in the test, two of which were of the type having driving pins in the bond plugs. An extractor to accurately measure the force exerted to extract the bonds was used.

Test was made with newly drilled holes and checked with depth gage to be sure they were reasonably consistent. The hand-driven bonds were applied by the regular signal maintenance forces who were instructed to drive them just as though they were making an ordinary replacement.

Following is the result of test showing in pounds, force required to extract:

	Hand drive		Machine drive	
	Individual	Average	Individual	Average
Bond A	1,675 } 1,925 }	1,800	3,350 } 3,450 }	3,400
Bond B	2,125 } 2,025 } 1,925 } 2,225 }	2,075	2,150 } 2,200 } 2,050 } 2,050 }	2,113
Bond C	2,125 } 2,375 }	2,200	2,850 } 2,770 }	2,810
Bond D	2,050 } 2,420 }	2,235	3,170 } 3,050 }	3,110
Summary average		2,078		2,858

Additional test was made with results as follows. It is to be noted that the hand-driven bonds in these instances were very purposely applied with heavy and extra hammer blows to determine if they would equal the machine application. The fact that some of these bonds were not tested under normal hand drive does not indicate that they cannot be so used.

	Hand drive		Machine drive	
	Individual	Average	Individual	Average
Bond A	3,300 } 3,570 }	3,435		
Bond X*			3,550 } 3,620 }	3,585
Bond Y**	3,850 } 3,620 }	3,735	4,120 } 3,400 }	3,760

* Bond A with cadmium plated terminal.

** Stainless steel terminal.

Test was also made of reapplying bonds a second time in newly drilled holes as well as applying new bonds in holes from which bonds had previously been extracted. The holding power was considerably reduced although not to a point where such application should be prohibited.

Test developed the following conclusions:

1. There was considerable difference in the holding power of the various bonds presently being manufactured, whether hand-driven or machine applied.
2. The machine application was more consistent and increased the holding power over hand-driven bonds installed in the customary manner.

Action Recommended
Acceptance as information,

A.A.R. SIGNAL SECTION REQUISITES.

TRACK CIRCUITS

1951

1. These requisites are for the purpose of setting forth the recommended general requirements for track circuits.

2. Track circuits shall be so designed that track relay will be in de-energized position if, when track circuit is dry, a shunt of 0.06 ohm resistance is connected across the track rails of the circuit, including fouling sections of turnouts.*

3. Track circuits shall be so designed and connected that the track relay will be in the de-energized position whenever any of the following conditions exist:

(a) A rail is broken or rail or switch frog removed, except when rail is broken or removed in the shunt fouling circuit of turnout or crossover, or when a break occurs within the limits of the joint bars or rail joint bond.

(b) A train, engine or car occupies any part of a track circuit including the fouling section of turnouts and crossovers, except turnouts of a hand-operated main track crossover protected by other means than track circuits.

(c) Where switch shunting circuit is used:

1. Switch point is not closed in normal position.

2. Switch is not locked where facing point lock with circuit controller is used.

3. Independently operated fouling point derail equipped with switch circuit controller is not in derailing position.

4. Track circuit fouling protection shall conform to Form 7004, Manual Part 206.

5. Bonding shall be in accordance with Specification 135, Manual Part 22.

6. Where relayed cut-section is used with non-coded direct current track circuits, the track relay at such cut-section shall, when in de-energized position, open the energy supply for and shunt the adjoining track circuit.

7. At grade crossing with an electric railroad, the electric energy for non-coded direct current track circuits shall feed away from the crossing.

8. Each track circuit, except where impracticable due to special conditions, and where single-rail track circuits are used, shall be insulated from all adjoining track circuits and from all non-track-circuited track.

9. The length of any section of a track circuit used for control of signal facilities which affects safety of train operation shall be greater than the maximum inner wheel base of any engine or car except when protected by trap or special circuit.

* See Formulae for Computing Minimum Allowable Resistance between Track Battery and Track and for Computing Related Current and Voltage Data, Manual Part 132.

10. In electrified territory where double-rail track circuits are used, the maximum length of track circuits shall be not greater than will provide a safe margin of broken-rail protection with the ballast leakage and spacing of traction cross-bonding that obtains.

11. Where dead section exceeds 35 ft., or the shortest outer wheel base of an engine operating over the dead section, special circuit shall be installed.

12. Location of insulated joints shall conform to Drawing 1634, 1635, 1636, 1637 or 1638, whichever is applicable.

13. The relays of coded track circuits on tracks signaled in one direction only and effective relay for selected direction on tracks signaled in both directions, should be at the entering end of the circuit.

14. Shunt wires and fouling wires, except shunt wires to switch circuit controller through which signal control circuits are controlled and track circuits are shunted, shall consist of at least two conductors and each shall be of sufficient conductivity that the track relay will be in de-energized position when the circuit is shunted.

15. In direct current track circuit design for locations where foreign current may be present consideration shall be given to Instructions for Minimizing the Effect of Foreign Current on Direct Current Track Circuits, Manual Part 127.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Requisites for Automatic Block Signaling Circuits)
A.A.R. SIGNAL SECTION REQUISITES.

AUTOMATIC BLOCK SIGNALING CIRCUITS

1951

1. *Purpose.*

(a) These requisites are for the purpose of setting forth the recommended general requirements for automatic block signaling circuits.

2. *General.*

(a) Automatic block signal circuits may be coded and operated by:

1. Direct current.
2. Alternating current.
3. Rectified alternating current.
4. Coded direct current.
5. Coded alternating current.
6. Coded rectified alternating current.

3. *Track circuits.*

(a) Track circuits shall be in accordance with Requisites for Track Circuits, Manual Part

4. *Signal operating circuits.*

(a) Both sides of the 45 and 90 deg. semaphore signal hold clear circuits, and at least one side of the motor circuit, shall be controlled through the contacts of the "H" relay or relays, or through the neutral contacts of the polar "HD" relay, and in addition one side of the 90 deg. hold clear and motor circuits shall be controlled through the contact of the "D" relay or the equivalent polar contact of the "HD" relay.

(b) One side of the lamp circuit of a light signal giving indications by control of lamp circuits shall be controlled through the neutral contacts of the "H" relay or relays. The lamp circuit of the proceed indication shall, in addition, be controlled through the "D" relay or equivalent contact of the polar "HD" relay.

(c) Both sides of local operating circuit of searchlight type signal shall be controlled through contacts of the "H", "D," or "HD" relay, where used.

(d) The circuit shall be so designed that:

1. The failure of any part of the circuit controlling the indication intended to be displayed shall not cause the signal to display a more favorable indication.

2. The failure of a lamp in a light signal or a semaphore signal arm assuming a false restrictive position shall not cause the signal to display a more favorable indication than intended.

5. *Non-coded circuits.*

(a) The energy supply for each signal control relay circuit, where an open-wire circuit or a common return circuit is used, shall be located at the end of the circuit farthest from the relay.

(b) The signal control circuit shall preferably be controlled through track relays within the entire block instead of track repeater relays; for additional protection, both sides of the circuit may be controlled and when the track relay is in de-energized position the relay end of circuit may be shunted.

(c) Where switch shunting circuits or relayed cut-sections are not used, one or both sides of the "H" relay circuit shall be controlled through a switch circuit controller or its repeating relay connected to each switch and independently operated fouling point derail when so equipped in the block, and the circuit shall be opened and relay end of circuit shunted when points of a switch are not in proper closed position or a derail is not in derailing position.

6. *Coded circuits.*

(a) The code may be transmitted by use of either alternating or direct current. If alternating current is used, the frequency shall be such as to minimize interference.

(b) The code form and frequency shall be the same as for cab signals, where used.

(c) Code producing apparatus shall deliver a substantially uniform code.

(d) Decoding apparatus shall be so designed that any damage to tuned equipment will not cause the signal to display a more favorable indication than intended.

(e) Code-following relays shall be so designed that they will repeat a given code without more distortion than is permitted by the decoding apparatus under practical operating conditions.

(f) Any code used to transmit a signal indication for a clear block shall be selected over the relays controlling the signal and the proper relays or circuit controllers at the leaving end of the block.

1. Where color light or semaphore signals are used, the code shall be selected over contacts connected with the signal operating mechanism or over relays which repeat the position of these contacts.

2. Where light signals giving indication by control of lamp circuits are used, one side of the code selecting circuits shall be taken over the same relays that control the lamp circuits.

7. *Circuit design.*

(a) The circuits shall be so designed that:

1. All control circuits, the functioning of which affects safety of train operation, shall be designed on the closed circuit principle.

2. Each signal governing train movements into a block shall be so controlled to display its most restrictive aspect when any of the following conditions exist:

(a) Train, engine or car is in the block.

(b) Points of a switch are not closed in proper position.

(c) Independently operated fouling point derail equipped with switch circuit controller is not in derailing position.

(d) Track relay is in de-energized position; or when signal control circuit is de-energized.

7. *Circuit design.*—Continued.

3. Hand-operated crossover between main tracks shall be protected to cause signals governing movements over either switch to display their most restrictive aspect when any of the following conditions exist:

(a) Where protection is provided by one or more track circuits and switch circuit controllers, and either switch is open or the crossover is occupied by a train, engine or car in such a manner as to foul the main track.

(b) Where facing point locks with a single lever are provided and either switch is unlocked.

(c) Where the switches are electrically locked, before the electric locking releases.

4. On track signaled for movements in both directions, signals shall be so controlled that proper restrictive indications will be provided to protect both following and opposing movements. Where required because of signal spacing, one of the following arrangements shall be used:

(a) Where opposing trains can simultaneously pass signals displaying proceed aspects, and the next signal in advance of each such signal then displays an aspect requiring a stop, the distance between opposing signals requiring a stop shall be not less than the aggregate of the stopping distances for movements in each direction.

(b) Where such opposing signals are spaced stopping distance apart for movements in one direction only, signals arranged to display restrictive aspects shall be provided in approach to at least one of the signals.

(c) Where such opposing signals are spaced less than stopping distance apart for movements in one direction, signals arranged to display restrictive aspects shall be provided in approach to both such signals.

5. Signal control and electric locking circuits shall not be selected through the contacts of instruments designed primarily for indicating or annunciating purposes in which an indicating element attached to the armature is arranged so that it can in itself cause improper operation of the armature.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for Automatic Block Signaling Circuits,
Manual Part 34.

(Revision of Instructions for Minimizing the Effect of
Foreign Current on Direct Current Track Circuits)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

MINIMIZING THE EFFECT OF FOREIGN CURRENT ON DIRECT CURRENT TRACK CIRCUITS

1951

1. The length of a track section must be such that the difference of potential between rails with no battery connected will not be sufficient to prevent drop-away of relay.*
2. One of the following arrangements of track circuits should be used:
 - (a) Short end-fed circuits.
 - (b) Center-fed circuits.
 - (c) Multiple relay circuits.
 - (d) Coded track circuits.
 - (e) Alternating current track circuits.
3. At grade crossing with an electric railroad, the electric energy for non-coded direct current track circuits shall feed away from the crossing.
4. Whenever the source of foreign current can be determined at other than electric railroad crossing locations, consideration should be given to placing the track energy supply at the end nearest the foreign current source.
5. Bonding and return circuit on electric railroads, in the vicinity, should be maintained in good condition.
6. Insulated joints should be maintained in good condition.
7. Ballast should be kept clear from rails and rail fastenings whenever practicable, and metallic connections from rail to ground should be avoided.
8. Bonding must be of the low-resistance type and maintained in good condition to insure low resistance.
9. Consideration should be given to the use of:
 - (a) A track relay requiring higher pick-up and drop-away values (higher ratio of drop-away to pick-up desirable).
 - (b) A low resistance track relay with maximum possible resistance between relay and track.
 - (c) A biased neutral relay with polarity opposing the foreign current, providing this is uni-directional.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded

Instructions for Minimizing the Effect of Foreign Current
on Direct Current Track Circuits, Manual Part 127.

* The interference from an external source bears a direct relation to the length of the circuit. The voltage of the foreign current in the rails is due to the difference of the earth potential at different points. The length of the sections to make them free from foreign current interference depends upon so many factors that no rules can be given as to the length to be used. The length should be shortened generally from the standards used in territory free from foreign current. The length depends also upon the rail resistance.

(Revision of Requisites for Electric Locks Applied to Hand-Operated Switches for Protection of Main Track Movements)
A.A.R. SIGNAL SECTION REQUISITES.

ELECTRIC LOCKS APPLIED TO HAND-OPERATED SWITCHES FOR PROTECTION OF MAIN TRACK MOVEMENTS

1951

1. These requisites are for the purpose of setting forth the recommended general requirements for electric locks applied to hand-operated switches for protection of main track movements.

2. Electric locks shall be of the forced-drop type.

3. Control circuits shall be designed on the closed circuit principle.

4. Signals governing movements over electrically locked switches shall be so controlled that proper restrictive indications will be displayed when electric lock is unlocked or switch is not in proper position.

5. Hand-operated electrically locked switches shall be locked in the normal position, and in addition, where signaling provides for facing movements through switch reversed at high or medium speed, switch shall be locked in the reverse position.

6. Electric locks may be provided with emergency means of unlocking, and operation of such device shall cause signals to display the proper restrictive indications.

7. Electric locks may be controlled automatically, semi-automatically or manually. They may be controlled individually or in groups as local operating conditions permit.

8. Electric locks may unlock to permit train or engine to enter main track by either of the following:

(a) Without a time interval when approach control track circuits are unoccupied.

(b) After signal control circuits have been opened and after the expiration of a time interval determined in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.

9. Electric locks may unlock to permit train or engine to leave main track by either of the following in addition to meeting the requirements for entering the track to which movement is to be made:

(a) Without a time interval by occupancy of short track circuit, preferably not exceeding 300 ft. in length immediately in advance of the switch or by equivalent arrangement.

(b) After the expiration of a predetermined time interval when initiated manually at the switch, or initiated by occupancy of track circuit or circuits immediately in advance of the switch.

10. Where manually controlled signals are used to govern movements toward an electrically locked switch, locks may unlock to permit train or engine to enter the main track when the following conditions are met:

- (a) Signals display their proper restrictive indications.
- (b) Associated electric locking is released.
- (c) All track circuits between such signals and switch are unoccupied, except as provided in Requisite 10-d-2.
- (d) The block being entered is either:
 - 1. Unoccupied and protected by a signal or signals displaying their proper restrictive indications, or
 - 2. Occupied by a train moving away from the switch.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for Electric Locks Applied to Hand-Operated Switches for Protection of Main Track Movements, Manual Part 211.

(Revision of Formulae for Computing Minimum Allowable Resistance between Track Battery and Track and for Computing Related Current and Voltage Data)

FORMULAE FOR COMPUTING MINIMUM ALLOWABLE
RESISTANCE BETWEEN TRACK BATTERY AND TRACK
AND FOR COMPUTING RELATED CURRENT
AND VOLTAGE DATA

1951

Proposed Revision

Columns for 0.04 and 0.02 ohms in Tables I-IV, inclusive, appearing on pages 4 through 7 of Manual Part 132 are to be deleted for the reason that they are of no further use to the craft. As there are no other changes, the affected tables are not reproduced in this Advance Notice.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Tables I-IV, inclusive, of Formulae for Computing Minimum Allowable Resistance between Track Battery and Track and for Computing Related Current and Voltage Data, Manual Part 132.

(Revision of A.A.R. Signal Section Specification 60-40)
A.A.R. SIGNAL SECTION SPECIFICATION 60-51.

INSTALLATION OF MADE GROUND

1. *Purpose.*

(a) This specification is for the purpose of providing for the installation of a low-resistance path to earth for abnormal potentials. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing installations when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Drawings referred to in the body of this specification form an essential part hereof.

(b) Contractor shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material and workmanship meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Ground rod.*

(a) Ground rod and fittings shall conform to Drawing 1424.
*R-6-a.

7. *Wire connection.*

(a) Wire connection between the single or multiple ground rods and the lightning arrester shall consist of a soft-drawn copper wire, size not smaller than No. 6 A.W.G., shall be run as directly as practicable, avoiding acute angles, and must have sufficient slack to avoid breakage from effects of frost.

(b) Air space of not less than $\frac{3}{8}$ in., or equivalent insulation, shall be maintained between wire connection and operating circuits.

(c) Wire connection to ground rod shall conform to Drawing 1424.

* Alternate requisites section.

8. Location.

(a) Ground rod shall be located as close as practicable to lightning arresters, but not less than 3 ft. from post, pole or foundation. Where space is not available to drive ground rod vertically, the rod may be at an angle so that the lower end is more than 3 ft. from post, pole or foundation.

(b) Ground rod shall be driven into the ground at least 8 ft. wherever practicable.

(c) Where multiple ground rods are used, they shall be spaced at least 6 ft. apart.

9. Resistance.

(a) Resistance between ground rod and the surrounding earth should preferably not exceed 15 ohms.

(b) If the preferred resistance cannot be obtained by driving a single ground rod, multiple ground rods, or sectional ground rods, the soil should be treated by digging a circular trench 15 in. wide, 18 in. deep and 48 inches in outside diameter around each rod; distribute 50 to 75 lbs. of rock salt, depending upon soil resistivity, in the trench; flood trench with water two or three times and then replace the soil in the trench.

(c) Where arrester location is on top of a fill and desired resistance of ground is not obtained at the arrester location, supplementary ground rod or rods may be driven at the foot of the slope where good soil exists, or ground rods may be driven under the track at an angle of about 45 deg., observing maintenance-of-way requirements. In such cases the ground rod at the arrester location must be retained.

10. Inspection of installation.

(a) Contractor shall advise the Purchaser days in advance of the time the installation will be completed and ready for final inspection. Purchaser will make inspection and tests within days after completion of the work.

11. Tests.

(a) Contractor shall make such tests as may be necessary to demonstrate, to the satisfaction of the Purchaser, that the apparatus, as installed, is in accordance with the requirements of the specifications and contract. These tests, unless otherwise specified, shall include the tests shown in section 11-b and shall be conducted in accordance with A.A.R. Signal Section instructions for testing. Contractor shall provide such instruments and apparatus as may be necessary for making tests. Instruments and apparatus shall remain the property of the Contractor.

(b) Ground resistance test shall be made in accordance with Instructions for Resistance of Made Grounds, Manual Part 61, unless otherwise specified by the Purchaser.

12. Completion.

(a) Resistance of grounds and date of inspection shall be indicated on a tag which shall be attached to the ground lead at the terminal.

(b) When the installation is completed, apparatus and surface of the ground which has been affected by the installation shall be left in a neat and clean condition.

Alternate requisites.

R-6-a.

Ground rod and fittings shall conform to

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 60-40—Installation of Made Ground for Protection
Against Abnormal Potentials, Manual Part 92.

(Revision of A.A.R. Signal Section Specification 52-43)
A.A.R. SIGNAL SECTION SPECIFICATION 52-51.

LOW-VOLTAGE LIGHTNING ARRESTERS

1. *Purpose.*

(a) This specification is for the purpose of providing valve and gap type lightning arresters of the indoor type for circuits of first voltage range, d.c., and first and second voltage range, a.c. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Specifications, drawings and standards.*

(a) Specifications, drawings and standards referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Type of mounting.
2. Inspection and tests as required.
3. Alternate requisites as required.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

6. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

7. *General design.*

(a) Arrester shall be of general design approved by the Purchaser.

(b) Arrester shall be so designed that moisture will not cause appreciable current leakage or interfere with the normal operation of the signal system.

7. *General design.*—Continued.

(c) Arrester shall be so designed that the discharge path will be non-conducting at voltages less than 700 volts d.c. *R-7-c.

(d) Arresters shall be so designed that the 60-cycle r.m.s. spark potential will be not less than 1.5 times the maximum a.c. voltage rating of the arrester. *R-7-d.

(e) The voltage permitted by the arrester during impulse characteristic tests shall not exceed 3,400 volts crest.

(f) Arrester, if furnished without base or binding posts, shall be adapted for mounting on terminal block shown on Drawing 1056, assembly 105615.

(g) Arrester shall be so designed that it will withstand the tests described in section 16, without becoming grounded, materially damaged or materially changed in operating characteristics.

8. *Mounting base.*

(a) Mounting base, if provided, shall be of porcelain or other fire-resisting and waterproof insulating materials of high dielectric and mechanical strength.

9. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(c) Binding posts for ground connections shall be so arranged that they may be connected together on adjacent arresters by means of a metal strip or bus bar.

10. *Finish.*

(a) All corrodible exposed metal parts shall be nickel plated in accordance with Specifications for Metallic Coating of Metals, Manual Part 63. *R-10-a.

11. *Insulation.*

(a) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

12. *Dielectric requirements.*

(a) A surface leakage distance of not less than $\frac{3}{8}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof except the discharge path.

(b) The assembled insulation of the arrester (with internal elements removed) shall withstand a 60-cycle voltage of 2,500 volts r.m.s. for 1 minute and an impulse voltage of 5,000 volts on the 1.5 by 40 microseconds full impulse test wave.

* Alternate requisites section.

13. *Identification.*

(a) Each arrester shall be plainly marked with Manufacturer's name and with the maximum a.c. and d.c. voltage rating for which the arrester is designed.

14. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

15. *Tests.*

(a) Manufacturer shall furnish, if required, complete test data from tests made in accordance with section 16 on arresters of identical design to those being supplied.

(b) Purchaser may require the Manufacturer to verify the data submitted. (Charge may be made if verification tests are required.)

(c) Verification tests may be made at the point of production, or at any properly equipped laboratory.

(d) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(e) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(f) Manufacturer shall state where tests, if required, are to be made. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

16. *Description of tests.*

(a) Impulse characteristic tests on valve and gap type arresters shall be made in accordance with applicable sections of current A.S.A. Standard C62.1 for Valve Type Lightning Arresters, as follows:

1. Impulse sparkover test using an average rate of voltage rise across arrester terminals to beginning of arrester discharge of 10 kv. per microsecond.

2. Impulse sparkover volt-time test over a range of times from 0.5 microsecond to the time for 1.5 by 40 microseconds critical test wave sparkover.

16. *Description of tests.*—Continued.

3. Discharge voltage-time test at 1,500 amperes crest with a 10 by 20 microsecond wave and also 5,000 amperes crest with a 10 by 20 microsecond wave.

4. Discharge current withstand test at 10,000 amperes crest with wave front duration of between 5 and 10 microseconds and wave tail between 10 and 20 microseconds.

(b) Duty cycle tests shall be made in accordance with applicable sections of current A.S.A. Standard C62.1 for Valve Type Lightning Arresters, as follows:

1. The arrester shall be connected across a circuit whose voltage equals the voltage rating of the arrester, and of such power capacity that the crest voltage across the arrester during the flow of follow current shall not be decreased more than 10 per cent below the crest of the open circuit voltage.

(c) Duty cycle tests for gap type arresters shall be as follows:

1. The arrester shall be connected across a circuit whose voltage equals the maximum voltage rating of the arrester under test, applied to the terminals of the arrester directly from power capacity of not less than 3 kv-a., and not more than 5 per cent impedance (including leads to arrester) at that voltage, for a.c. arrester used on 0-175 volt a.c. signal circuits, or directly from power capacity of not less than 240 ampere-hour battery, or equivalent, for d.c. arrester used on 0-30 volt d.c. signal circuits.

(d) The standard operating duty cycle test on valve and gap type arresters shall be 30 unit operations at intervals not greater than 1 minute. The impulse test current used to initiate follow current shall have a 10 by 20 microsecond wave shape with a crest value of 1,500 amperes.

(e) At completion of standard operating duty cycle tests, the condition of arrester should be judged by:

1. Volt-time and ampere-time impulse characteristics, as determined by typical impulse test.

2. Insulation resistance (megger test).

3. Physical condition.

4. Oscillograms taken on duty cycle test.

17. *Packing.*

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

18. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents, shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

19. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-7-c.

Arrester shall be so designed that the discharge path will be non-conducting at voltages less than volts d.c.

R-7-d.

Arresters shall be so designed that the 60-cycle r.m.s. spark potential will be not less than times the maximum a.c. voltage rating of the arrester.

R-10-a.

All corrodible exposed metal parts shall be plated.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 52-43—Low-Voltage Lightning Arrester,
Manual Part 95.

COOPERATIVE REPORT

AMERICAN PETROLEUM INSTITUTE
CORRELATING COMMITTEE ON CATHODIC PROTECTION*

R. B. Amsden, Representative

A. B. Armistead, Alternate

Progress reports on the activities of the Correlating Committee on Cathodic Protection, a continuing organization composed of representatives of eleven industry associations and communication companies, and sponsored by the American Petroleum Institute, were presented as information in A.A.R. Signal Section 1946, 1947 and 1948 Proceedings, Vols. XLIV, XLV and XLVI, pp. 164-A, 154 and 249, respectively.

* See A.A.R. Signal Section 1942 Proceedings, Vol. XL, p. 153-A.

At a meeting of the Committee held at the Jefferson Hotel, St. Louis, Mo., on April 4, 1950, a draft of Bulletin III—Cathodic Protection Technical Practices was reviewed and revised. Certain parts of the draft requiring further study were referred back to a Subcommittee to be rewritten and forwarded to the Chairman for some editorial revision and the addition of references to a bibliography of practical articles on the subject which have appeared in the various technical journals and to several books dealing with cathodic protection.

The completed Bulletin III, after approval by all concerned, is now ready for reproduction and distribution by each of the several associations or industries to its membership in such manner as it deems most effective and financed in its customary manner.

This is one of a series of four bulletins which are intended to acquaint the managements of pipe line, railroad and communication companies with the fact that individual cathodic protection installations often create problems which can be equitably solved only by joint study and action, requiring cooperation of all managements concerned, pointing out that obligation for notification to others rests with the company making the cathodic installation, outlining notification procedure and providing effective means for exchange of location data and providing information that will assist in the design, installation and operation of cathodic protection to avoid adverse effects on crossed or adjacent structures.

Bulletin 1—Management Information on Cathodic Protection of Buried Metallic Structures Against Corrosion, describes cathodic protection in non-technical language and indicates in general terms how it may be applied and what some of the problems are in connection with its use. Bulletins II—Notification Procedures and IV—Joint Cathodic Protection Systems, further discuss these problems and indicate means for their cooperative solution. Bulletin III discusses the more important technical problems in somewhat more detail and indicates what practices are currently being followed by corrosion engineers; it points out specifically that locations near railroad tracks employing signal systems which might be falsely operated by direct currents entering the rails should be avoided and that, if there is any question of interference, cooperative tests should be made with the railroad engineers to determine if adverse effects are likely.

Action Recommended
Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
SECTIONAL COMMITTEE ON PREFERRED VOLTAGES,
100 VOLTS AND UNDER—PROJECT C67

R. B. Amsden, Representative

Although standardization of voltages for alternating current systems and equipment over 100 volts goes back to the beginning of this century, there had been no attempt made in this country to standardize voltages 100 and under. The use of such voltages, however, has increased steadily in number and diversity of applications and the need for such standardization has become evident.

The formulation of a list of preferred voltages, 100 volts and under, for generation from any source, and for distribution and utilization purposes, exclusive of secondary voltages in reduced-voltage motor starters, has been under consideration for several years by a Sectional Committee of the American Standards Association, sponsored by the Electrical Standards Committee. Twenty nation-wide organizations have joined in the activity, as follows:

American Institute of Electrical Engineers.
American Welding Society.
The Association of American Battery Manufacturers, Inc.
Association of American Railroads, Engineering Division, Signal Section.
Electric Light and Power Group.
Electrical Testing Laboratories, Inc.
The Electro-Chemical Society, Inc.
The Electrical Industrial Truck Association.
Institute of Radio Engineers.
National Electrical Contractors Association.
National Electrical Manufacturers Association.
Radio-Television Manufacturers Association.
A.S.A. Sectional Committee on Specifications for Dry Cells and Batteries, C18.
Society of Automotive Engineers.
Telephone Group.
Underwriters' Laboratories, Inc.
U.S. Department of the Army.
U.S. Department of the Navy, Bureau of Aeronautics.
U.S. Department of the Treasury, Coast Guard.

The Chairman of the Committee is Mr. A. C. Monteith, Vice-Pres., Westinghouse Electric Corp., Pittsburgh, Pa. and the Secretary is Mr. Roy Eason, National Electrical Manufacturers Assn., New York, N. Y.

At the last meeting of the Committee held at the N.E.M.A. headquarters, 155 East 44th St., New York, N. Y., on January 30, 1951, there was full discussion on the use of the terms "Nominal Voltage" and "Rated Voltage." The Committee concluded that, in fact, the preferred nominal voltages to be set up in a proposed American Standard represent a long term objective at which the industry should aim, in the interest of reducing the large number of voltages under 100 volts now used for different applications.

The Committee recognized that such a complete changeover cannot be made over a period of months or even in a year or two. However, the proposed American Standard establishes the standard preferred nominal voltages toward which objective the industry may strive when new or revised designs of equipment are put into production.

In addition, the Committee emphasized that the "nominal" voltage need not be, and usually is not, either the "rated" or the "design center" voltage of the equipment. It is only a convenient designation assigned to a particular apparatus for the purpose of indicating the approximate circuit voltage on which it is to be used. Thus the Committee recognized that line voltages are almost never at the actual rated value but vary as the line load varies.

With the above conclusions in mind, the Committee developed a proposed standard entitled "American Standard for Preferred Nominal Voltages 100 Volts and Under." The Standard delineates the scope, lists the usual sources of low voltage and includes the definitions of nominal voltage and rated voltage. The direct current and alternating current preferred nominal voltages are listed as follows:

Table 1—Direct Current Preferred Nominal Voltages

Voltages from dry battery combinations		Voltages from other sources	
1.5	22.5	2	40
3.0	30.0	4	48
4.5	33.0	6	60
6.0	45.0	12	72
7.5	67.0	24	80
9.0	90.0	32	90
15.0			

Table 2—Alternating Current Preferred Nominal Voltages, Single Phase

4	24	48
6	32	60
12	40	80

An Appendix, which lists typical rated voltages in common use for the kind of equipment indicated, is attached to the Standard as information but is not a part of the Standard itself. The rated voltages listed in the Appendix are interim values, to be used only until such time as it becomes practicable to go over to the preferred nominal voltages shown in the Standard. When the preferred nominal voltages come into general use, the Appendix will be discarded entirely.

The Committee decided that the Appendix should show only representative voltages commonly used at the present time, rather than attempt to present an all-inclusive listing. The rated voltages included in the Appendix, classified according to their applications, are as follows:

Table 1—Rated Voltages for Electronic Tubes and Rectifiers

Filament voltages for gas-filled rectifiers			Filament voltages for vacuum tubes		Plate supply voltages		
2.5	5	6.3	1.25	22.5	32	90	
			2.5	28	45	100	
1.8, 2.0, 2.2 and 2.6			5	30	67.5		
volts are also used for			6.3				
low-voltage rectifiers			12.6				
			26.5				
			35				

Table 2—Rated Voltages for Incandescent Lamps

Flashlights and miscellaneous service			Automobiles, trucks, aircraft and yachts			Trains and home service		Railroad signal service		
1.1	2.3	3.8	6-8	12-16	24-28	30	60	3.5	10	13.5
1.2	2.4	5				32	75	6	11	14
1.3	2.5	6.2				34		6-8	12	18
2.2	3.6							8	12-16	24

Table 3—Rated Voltages for Miscellaneous Equipment

Application	Rated volts		Application	Rated volts	
Telephones, alarm and signal systems	a.c.	4	Substation control	d.c.	12
		12			18
		24			24
		48			48
		60			
	d.c.	4	Electric vehicles	a.c.	12
		6			24
		9			48
		12			
		24			
		32	Industrial trucks	d.c.	60
		48			85
		60			
Railroad signals	d.c.	2.5	Specialty transformers	a.c.	4
		3.5			8
		6			12
		8			16
		10			20
		12			24
		13.5			
		24			

Table 3—Continued

Application	Rated volts		Application	Rated volts	
Train air conditioning	a.c.	30	Aircraft	a.c.	14
		37.5			28
		75			
				d.c.	14
					28

The Standard, including the Appendix, was submitted to all members of the Sectional Committee for letter ballot vote and was approved. The Secretary tabulated the results of the ballot and submitted the tabulation and the Standard to the Electrical Standards Committee of the A.S.A. for approval as an American Standard.

Action Recommended
Acceptance as information.

COMMITTEE V—CONTRACTS AND INSTRUCTIONS

Personnel

E. B. Platt, Chairman

F. Youngwerth, Vice-Chairman

G. D. Booth	W. C. McConnell
C. D. Cronk	C. L. Ott
W. N. Donahue	G. R. Pflasterer
R. C. Dueland	J. A. Phillips
A. C. Eastman	E. L. Rogers
O. Falkenstein	G. C. Schindler
A. T. Hunot	W. L. Scott
F. M. Kunker	S. P. Searle

G. A. Washburn

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Instructions for testing signal installations before placing in service.
4. Definitions for technical terms used in signaling.
5. Forms for reporting progress of the component parts of new signal installations and expenditures for labor.
6. Investigate and report on a simplified system of numbering and identification of wires and circuits which does not require the changing of nomenclature and tags on wayside circuits when a minor change is made.
7. Investigate and report on the use of portable induction type telephones by signal forces.
8. Specification covering an instrument for determining ground resistance.
9. Recommend uniform practice in reporting track circuit rail bond failures under I.C.C. classifications, collaborating with Committees I and IV.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Instructions for Light and Motor Semaphore Signals, Manual Part 54.
Revision of Definitions for Technical Terms Used in Signaling, Manual Part 55.
Revision of Instructions for Automatic Block Signal Systems, Manual Part 102.
Revision of Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.
Revision of Instructions for Switch Circuit Controllers, Manual Part 134.
Revision and consolidation of Instructions for Automatic Interlocking and Instructions for Interlocking, Manual Parts 59 and 138.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

Revision of Instructions for Electric Locking, Manual Part 199.

Revision of Instructions for Signal Protection for Movable Bridges, Manual Part 233.

8. Specification 257-51.

Cooperative report. Purchases and Stores Division, A.A.R.—General Reclamation Committee.

Cooperative report. American Standards Association—Graphical Symbols and Abbreviations—Project Z32.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

Disposition of 1950 Letter Ballot Subjects

The following subjects presented by Committee V at the 1950 Annual Meeting were submitted to letter ballot and officially approved:

Definitions for Technical Terms Used in Signaling—Now in Manual Part 55.
Instructions for Non-Coded Direct Current Track Circuits—Now in Manual Part 8.

A.A.R. Sig. Sec. 1662D—Graphical Symbols—Tracks and Highway Crossings—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1673E—Graphical Symbols—Relays—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1674F (Three Sheets)—Graphical Symbols—Relay Contacts—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1680C (Two Sheets)—Graphical Symbols—Circuit Appurtenances—Now in Drawing Section of Manual.

A.A.R. SIGNAL SECTION SPECIFICATION 257-51.

GROUND RESISTANCE TESTING INSTRUMENT

1. *Purpose.*

(a) This specification is for the purpose of providing a portable self-contained ground resistance testing instrument of the direct-reading crossed-coil ohmmeter type.

2. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

3. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Class of instrument as specified in section 6.
2. Range of instrument as specified in section 7.
3. Carrying case when required.
4. Traveling case when required.
5. Test leads when required.
6. Reference ground rods when required.
7. Inspection and tests as required.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *Design.*

(a) Instrument shall be of a design approved by the Purchaser.

(b) Instrument shall be completely self-contained, equipped with hand-cranked generator to supply necessary test current, and with terminals suitable for making ground resistance tests as follows:

1. Single-test, direct-reading method using two reference grounds.
2. Direct reference method using a single reference ground of low or known resistance.
3. Three-point method using two reference grounds and involving three tests with calculations.

(c) Proper operation of instrument shall be obtained with hand crank rotation speed of 160 r.p.m. or less.

(d) Selecting switch shall be provided in all instruments having multiple ranges and single scale.

6. *Classes.*

(a) Instruments shall be of three general classes:

1. Class 1 for use where a relatively high degree of accuracy is desired, and very low range or high sensitivity is required with minimum scale length of $3\frac{1}{4}$ in.2. Class 2 for use where less accuracy than that available in Class 1 instruments is adequate, also where either low range or high sensitivity is not required with minimum scale length of $2\frac{3}{4}$ in.3. Class 3 for use where instruments of lighter weight and smaller size than Class 2 are desired, having a scale for each of two ranges with a minimum length of $2\frac{1}{4}$ in.7. *Ranges.*

(a) Ohmic range of the various instruments in each class shall be as follows:

1. Class 1.

(a) 0 to 3, 0 to 30 and 0 to 300.

(b) 0 to 3, 0 to 30, 0 to 300 and 0 to 3,000.

(c) 0 to 3, 0 to 30, 0 to 3,000 and 0 to 30,000.

(d) 0 to 1, 0 to 10, 0 to 100 and 0 to 1,000.

2. Class 2.

(a) 0 to 300.

(b) 0 to 600.

(c) 0 to 30 and 0 to 300.

(d) 0 to 60 and 0 to 600.

(e) 0 to 300 and 0 to 3,000.

3. Class 3.

(a) 0 to 40 and 0 to 200.

(b) 0 to 100 and 0 to 500.

8. *Scales.*

(a) Scales shall be individually calibrated and so constructed as not to be affected by moisture or changes in temperature.

(b) Length of scales shall be measured in the upper arc and divisions shall be as follows:

	Minimum length of scale, in.	Minor divisions	Major divisions
Class I:			
3-ohm full scale range.....	$3\frac{1}{4}$	30	6
1-ohm full scale range.....	$3\frac{1}{4}$	100	10
Class 2.....	$2\frac{3}{4}$	See Note 1	
Class 3.....	$2\frac{1}{4}$	See Note 1	

Note 1.—Since the scale graduations used in these classes are less uniformly spaced than those in Class 1, the graduations and markings cannot be adequately specified. Facsimile scales of the ranges specified shall be submitted to the Purchaser for approval.

(c) Each major division of the scale shall be clearly emphasized throughout the maximum range of the instrument.

9. *Binding posts.*

(a) Connections to instrument shall be made on binding post type terminals or other approved terminals.

(b) Terminals shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(c) Cases shall be plainly and permanently marked to identify terminals as follows:

Classes 1 and 3	P ₁	C ₁	P ₂	C ₂
Class 2	G	P	C	

(d) In the case of Class 1 instruments, a link shall be provided so that the P₁ C₁ binding posts can be conveniently connected together or separated.

(e) If binding post terminal nuts are used they shall be so arranged that they will not come off in normal use. Suitable insulation against accidental contact shall be provided for all terminations.

10. *Selecting switches.*

(a) Selecting switches shall be plainly and permanently marked to identify the ranges and terminals as connected.

11. *Pointer.*

(a) Pointer shall be the knife-edge type.

12. *Moving element.*

(a) The moving element shall turn on hardened accurately ground and highly polished steel or equivalent pivots, bearing on highly polished first-quality sapphires or equivalent jewels. The moving element shall be practically aperiodic.

13. *Heating.*

(a) Instruments shall not over-heat or show an appreciable error when operating continuously under short circuit conditions.

14. *Case.*

(a) Instrument case shall be moisture and dust-proof and shall have a neat and durable finish.

15. *Sealing.*

(a) Instruments shall be sealed to prevent any changes or adjustments except by authorized persons.

16. *Errors due to temperature.*

(a) Instruments furnished in accordance with this specification must be so designed that error due to changes in temperatures between 4 deg. F. below zero and 122 deg. F. above zero shall not exceed 2 per cent of full scale length.

17. *Accuracy.*

- (a) All instruments shall be tested at 77 deg. F.
- (b) Instruments in Class 1 shall be inherently accurate to within 1 per cent of full scale length.
- (c) Instruments in Class 2 shall be inherently accurate to within $1\frac{1}{2}$ per cent of full scale length.
- (d) Instruments in Class 3 shall be inherently accurate to within 2 per cent of full scale length.

18. *Test accuracy.*

- (a) The Manufacturer shall furnish the Purchaser with data concerning the potential reference ground rod resistances for which the instrument is calibrated in each range, and the maximum test error resulting from a resistance twice this amount.

19. *Test current characteristics.*

- (a) The test current produced by the instrument and passed through the earth shall be alternating (periodically reversing), and of a frequency that can be varied so that beat frequencies between the test current frequency and the frequency of any voltage in the earth will have negligible effect on the action of the instrument pointer.

20. *Name plate.*

- (a) Name plate showing Manufacturer's name, model and serial number shall be attached to each instrument unless this information is shown on dial.

21. *Instruction plate.*

- (a) Each instrument shall have permanently attached to it an instruction plate or card giving brief but complete information as to external connections and operation.

22. *Dielectric requirements.*

- (a) The instrument assembled shall withstand for 1 minute an insulation test, at place of manufacture, of 1,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.
- (b) Separate windings, which are insulated from each other, shall withstand for 1 minute an insulation test of 250 volts a.c. between their terminals.

23. *Finish.*

- (a) Metal parts shall be protected against corrosion except where such protection will interfere with the proper functioning of that part.
- (b) Material used for protection against corrosion shall neither melt nor flake under ordinary conditions between temperatures of 4 deg. F. below zero and 122 deg. F. above zero.

24. *Inspection.*

(a) Purchaser may inspect the completed product.

(b) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all shipping charges.

(c) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

25. *Instruction manual.*

(a) Manufacturer shall provide with each instrument an instruction manual which adequately covers the operation and methods of test for which the instrument is intended.

26. *Packing.*

(a) Instrument shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

27. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

28. *Warranty.*

(a) Manufacturer shall warrant the instrument covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any instrument which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Definitions for Technical Terms Used in Signaling)
A. A. R. SIGNAL SECTION DEFINITIONS.

TECHNICAL TERMS USED IN SIGNALING

1951

Acknowledger, or Forestalling Switch. (Revision)

See definition for Device, Acknowledging.

Acknowledging. (Revision)

Operation by enginemen of acknowledging device.

Acknowledging Device. (New)

See definition for Device, Acknowledging.

Acknowledging Time. (New)

See definition for Time, Acknowledging.

Acknowledgment Circuit. (New)

See definition for Circuit, Acknowledgment.

Application, Brake; Full Service. (New)

An application of the brakes resulting from a continuous or a split reduction in brake pipe pressure at a service rate until maximum brake cylinder pressure is developed. As applied to an automatic or electro-pneumatic brake with speed governor control, an application other than emergency which develops the maximum brake cylinder pressure, as determined by the design of the brake equipment for the speed at which the train is operating. (I.C.C.)

Approach Locking. (Superseding Electric Approach Locking)

See definition for Locking, Approach.

Arm, Semaphore. (Revision)

The part of a semaphore signal displaying an aspect. It consists of a blade fastened to a spectacle. (I.C.C.)

Aspect, False Restrictive. (New)

The aspect of a signal that is more restrictive than intended.

Aspect, Phantom Signal. (New)

An aspect displayed by a light signal, different from the aspect intended, caused by a light from an external source being reflected by the optical system of the signal. (I.C.C.)

**Aspect, Signal.* (Revision)

The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train; the appearance of a cab signal conveying an indication as viewed by an observer in the cab. (Standard Code)

* Under revision for Standard Code.

**Automatic Block Signal System.* (Superseding Automatic Block System)
See definition for System, Automatic Block Signal.

Automatic Train Stop System. (New)
See definition for System, Automatic Train Stop.

Bar, Locking. (Revision)
A bar in an interlocking machine to which the locking dogs are attached. (I.C.C.)

Bed, Locking. (Revision)
That part of an interlocking machine that contains or holds the tappets, locking bars, cross-locking, dogs, and other apparatus used to interlock the levers. (I.C.C.)

Blade, Semaphore. (Revision)
The extended part of a semaphore arm which shows the position of the arm. (I.C.C.)

Block, Absolute. (Revision)
A block in which no train is permitted to enter while it is occupied by another train. (I.C.C.)

Block, Latch. (Revision)
The lower extremity of a latch rod which engages with a square shoulder of the segment or quadrant to hold the lever in position. (I.C.C.)

Block, Lever Latch. (Revision)
See definition for Block, Latch.

Block System, Automatic. (Term and cross-reference to be deleted)

Bond, Rail. (Revision)
A metallic connection attached to adjacent rails to insure electrical conductivity.

Bond, Rail Joint. (New)
A metallic connection attached to adjoining rails to insure electrical conductivity. (I.C.C.)

Brake Application, Full Service. (New)
See definition for Application, Brake; Full Service.

Bridge, Movable. (Revision)
That section of a structure bridging a navigable waterway so designed that it may be displaced to permit passage of traffic on the waterway. (I.C.C.)

Cab. (Revision)
The compartment of a locomotive from which the propelling power and power brakes of the train are manually controlled. (I.C.C.)

* Under revision for Standard Code.

Changer, Pole. (Revision)

A device by which the direction of current flow in an electrical circuit may be changed. (I.C.C.)

Characteristics, Operating. (Revision)

As applied to electrical apparatus, the measure of the electrical values at which the apparatus operates. (Drop-away, pick-up, working value, etc.) (I.C.C.)

Chart, Dog. (Revision)

A diagrammatic representation of the mechanical locking for an interlocking machine, used as a working plan in making up, assembling and fitting locking. (I.C.C.)

Circuit, Acknowledgment. (New)

A circuit consisting of wire or other conducting material installed between the track rails at each signal in territory where an automatic train stop system or cab signal system of the continuous inductive type with two-indication cab signals is in service, to enforce acknowledgment by the engineman at each signal displaying an aspect requiring a stop. (I.C.C.)

Circuit, Closed. (Revision)

See definition for Principle, Closed Circuit.

Circuit, Common Return. (Revision)

A term applied where one wire is used for the return of more than one electric circuit. (I.C.C.)

Circuit, Control. (New)

An electrical circuit between a source of electric energy and a device which it operates. (I.C.C.)

Circuit, Cut-In. (New)

A roadway circuit at the entrance to automatic train stop, train control or cab signal territory by means of which locomotive equipment of the continuous inductive type is actuated so as to be in operative condition. (I.C.C.)

Circuit, Line; Double-Wire. (New)

An electric circuit not employing a common return wire; a circuit formed by individual wires throughout. (I.C.C.)

Circuit, Separate Return. (Revision)

See definition for Circuit, Line; Double-Wire.

Circuit, Shunt Fouling. (New)

The track circuit in the fouling section of a turnout, connected in multiple with the track circuit in the main track. (I.C.C.)

Circuit, Switch Shunting. (New)

A shunting circuit which is closed through contacts of a switch circuit controller. (I.C.C.)

Circuit, Track. (Revision)

An electrical circuit of which the rails of the track form a part. (I.C.C.)

Circuit, Track; Coded. (Revision)

A track circuit in which the energy is varied or interrupted periodically. (I.C.C.)

Circuit, Trap. (Revision)

A term applied to a circuit used at locations where it is desirable to protect a section of track but where it is impracticable to maintain a track circuit.

Closed Circuit. (Revision)

See definition for Principle, Closed Circuit.

Closed Circuit Principle. (New)

See definition for Principle, Closed Circuit.

Conflicting Movements. (New)

See definition for Movements, Conflicting.

Conflicting Routes. (New)

See definition for Routes, Conflicting.

Contact Element. (New)

See definition for Receiver.

Control Circuit. (New)

See definition for Circuit, Control.

Control Machine. (New)

See definition for Machine, Control.

Control Machine, All-Relay Interlocking. (New)

See definition for Machine, Control.

Control Operator. (New)

See definition for Operator, Control.

Control Station. (New)

See definition for Station, Control.

Controlled Point. (New)

See definition for Point, Controlled.

Controller, Circuit. (Revision)

A device for opening and closing electric circuits. (I.C.C.)

Controller, Circuit; Movable Bridge. (Superseding Controller, Circuit;
Drawbridge—with no change in the definition)

Controller, Circuit; Switch. (Revision)

A device for opening and closing electric circuits, operated by a rod connected to a switch, derail or movable point frog. (I.C.C.)

Coupler, Movable Bridge. (Superseding Coupler, Drawbridge—with no change in the definition)*Cover Glass.* (New)

See definition for Roundel.

Current, Foreign. (Revision)

A term applied to stray electric currents which may affect a signaling system, but which are not a part of the system. (I.C.C.)

Current, Leakage. (Revision)

A stray electric current of relatively small value which flows through or across the surface of insulation when a voltage is impressed across the insulation. (I.C.C.)

Cut-In Circuit. (New)

See definition for Circuit, Cut-In.

Cut-Section. (Revision)

A location other than a signal location where two adjoining track circuits end within a block. (I.C.C.)

Cut-Section, Relayed. (New)

A cut-section where the energy for one track circuit is supplied through front contacts or through front and polar contacts of the track relay for the adjoining track circuit. (I.C.C.)

Dead Section. (New)

See definition for Section, Dead.

De-energized Position. (New)

See definition for Position, De-energized.

Delay Time. (New)

See definition for Time, Delay.

Detector, Point. (Revision)

A circuit controller which is part of the switch operating mechanism and operated by a rod connected to a switch, derail or movable point frog to indicate that the point is within a specified distance of the stock rail. (I.C.C.)

Detector, Point (with Latch-Out Device). (Revision)

See definition for Device, Latch-Out (Point Detector).

Device, Acknowledging. (New)

A manually operated electric switch or pneumatic valve by means of which, on a locomotive equipped with automatic train stop or train control device, an automatic brake application can be forestalled, or by means of which, on a locomotive equipped with an automatic cab signal device, the sounding of the cab indicator can be silenced. (I.C.C.)

Device, Latch-Out (Point Detector). (New)

A device, applied to a point detector, that will operate when the switch points are opened by means other than the operation of switch operating mechanism, to hold the circuit controller in the position indicating that the point has not remained within a specified distance of the stock rail.

Device, Reset. (New)

A device whereby the brakes may be released after an automatic train control brake application. (I.C.C.)

Distance, Stopping. (New)

The maximum distance on any portion of any railroad which any train operating on such portion of railroad at its maximum authorized speed, will travel during a full service application of the brakes, between the point where such application is initiated and the point where the train comes to a stop. (I.C.C.)

Dog, Locking. (Revision)

A steel block attached to a locking bar or tappet of an interlocking machine, by means of which locking between levers is accomplished. (I.C.C.)

Dog, Swing. (New)

A locking dog mounted in such a manner that it is free to rotate on a trunnion which is riveted to a locking bar. (I.C.C.)

Double-Wire Line Circuit. (New)

See definition for Circuit, Line; Double-Wire.

Drawbridge Circuit Controller. (Superseded by Movable Bridge Circuit Controller)*Drawbridge Coupler.* (Superseded by Movable Bridge Coupler)*Drawbridge Lock.* (Superseded by Movable Bridge Lock)*Drawbridge Rail Lock.* (Superseded by Movable Bridge Rail Lock)*Driving Piece.* (New)

See definition for Piece, Driving.

Driving Piece, Detector Bar. (Revision)

See definition for Piece, Driving; Detector Bar.

Drop-Away. (Revision)

See definition for Value, Release.

Electric Approach Locking. (Superseded by Approach Locking)*Electric Drawbridge Lock.* (Superseded by Electric Movable Bridge Lock)*Electric Indication Locking.* (Superseded by Indication Locking)*Electric Interlocking Machine.* (Revision)

See definition for Machine, Interlocking; Electric.

Electric Movable Bridge Lock. (Superseding Electric Drawbridge Lock)

See definition for Lock, Movable Bridge; Electric.

Electric Route Locking. (Superseded by Route Locking)*Electric Section Locking.* (Superseded by Section Locking)*Electric Time Locking.* (Superseded by Time Locking)*Electric Traffic Locking.* (Superseded by Traffic Locking)*Electro-Pneumatic Interlocking Machine.* (Revision)

See definition for Machine, Interlocking; Electro-Pneumatic.

Electro-Pneumatic Switch. (New)

See definition for Switch, Electro-Pneumatic.

Element, Contact. (New)

See definition for Receiver.

Element, Roadway. (Revision)

That portion of the roadway apparatus of automatic train stop, train control or cab signal system, such as electric circuit, inductor, magnet, ramp or trip arm to which the locomotive apparatus of such system is directly responsive. (I.C.C.)

Element, Track. (Revision)

See definition for Element, Roadway.

Face, Locking. (New)

The locking surface of a locking dog, tappet or cross-locking of an interlocking machine. (I.C.C.)

Facing Movement. (New)

See definition for Movement, Facing.

False Restrictive Aspect. (New)

See definition for Aspect, False Restrictive.

False Restrictive Position. (New)

See definition for Aspect, False Restrictive.

Feature, Restoring. (New)

An arrangement on a power-operated switch movement by means of which power is applied to restore the switch movement to full normal or to full reverse position, before the driving bar creeps sufficiently to unlock the switch, with control lever in normal or reverse position. (I.C.C.)

Forced-Drop Electric Lock. (New)

See definition for Lock, Electric; Forced-Drop.

ForeSTALL. (New)

As applied to an automatic train stop or train control device, to prevent an automatic brake application by operation of an acknowledging device or by manual control of the speed of the train. (I.C.C.)

ForeSTALLING Switch, Acknowledger or. (Revision)

See definition for Device, Acknowledging.

Full Service Brake Application. (New)

See definition for Application, Brake; Full Service.

Glass, Cover. (New)

See definition for Roundel.

Hand-Operated Switch. (New)

See definition for Switch, Hand-Operated.

Indication Locking. (Superseding Electric Indication Locking)

See definition for Locking, Indication.

**Indication, Signal.* (Revision)

The information conveyed by the aspect of a signal. (Standard Code)

Initial Terminal. (New)

See definition for Terminal, Initial.

Interlocked Route. (New)

See definition for Route, Interlocked.

Interlocked Switch. (New)

See definition for Switch, Interlocked.

Interlocking, Automatic. (Revision)

An arrangement of signals, with or without other signal appliances, which functions through the exercise of inherent powers as distinguished from those whose functions are controlled manually, and which are so interconnected by

* Under revision for Standard Code.

means of electric circuits that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication. (I.C.C.)

Interlocking Limits. (Revision)

See definition for Limits, Interlocking.

Interlocking Machine. (New)

See definition for Machine, Interlocking.

Interlocking Machine, Electric. (Revision)

See definition for Machine, Interlocking; Electric.

Interlocking Machine, Electro-Mechanical. (Revision)

See definition for Machine, Interlocking; Electro-Mechanical.

Interlocking Machine, Electro-Pneumatic. (Revision)

See definition for Machine, Interlocking; Electro-Pneumatic.

Interlocking Machine, Power. (Term and cross-reference to be deleted)

Interlocking, Manual. (New)

An arrangement of signals and signal appliances operated from an interlocking machine and so interconnected by means of mechanical and/or electric locking that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication. (I.C.C.)

Joint, Rail; Insulated. (Revision)

A joint in which electrical insulation is provided between adjoining rails. (I.C.C.)

Latch Block. (Revision)

See definition for Block, Latch.

Latch-Operated Locking. (New)

See definition for Locking, Latch-Operated.

Latch-Out Device (Point Detector). (New)

See definition for Device, Latch-Out (Point Detector).

Lens. (Revision)

A glass or similar product, usually circular in shape, designed to collect the rays of light directly from a small light source and focus them into a beam of definite shape depending upon the design. It may be clear or colored as required.

Lever Latch Block. (Revision)

See definition for Block, Latch.

Lever-Operated Locking. (New)

See definition for Locking, Lever-Operated.

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Limits, Interlocking. (Revision)

The tracks between the opposing home signals of an interlocking. (Standard Code)

Line, Open Wire. (New)

An overhead wire line consisting of single conductors as opposed to multiple-conductor cables. (I.C.C.)

Link, Rocker. (Revision)

That portion of an interlocking machine which transmits motion between the latch and the universal link. (I.C.C.)

Lock, Bolt. (Revision)

A mechanical lock so arranged that if a switch, derail or movable point frog is not in the proper position for a train movement, the signal governing that movement cannot display an aspect to proceed; and that will prevent a movement of the switch, derail or movable point frog unless the signal displays its most restrictive aspect. (I.C.C.)

Lock, Drawbridge. (Superseded by Lock, Movable Bridge)*Lock, Drawbridge; Electric.* (Superseded by Lock, Movable Bridge; Electric)*Lock, Electric.* (Revision)

A device to prevent or restrict the movement of a lever, a switch, or a movable bridge, unless the locking member is withdrawn by an electrical device, such as an electromagnet, solenoid, or motor. (I.C.C.)

Lock, Electric; Forced-Drop. (New)

An electric lock in which the locking member is mechanically forced down to the locked position. (I.C.C.)

Lock, Facing Point. (Revision)

A mechanical lock for a switch, derail or movable point frog, comprising a plunger stand and a plunger which engages a lock rod attached to the switch point to lock the operated unit. (I.C.C.)

Lock, Movable Bridge. (Superseding Lock, Drawbridge)

A device used to insure that a movable bridge is in proper position for the movement of trains.

Lock, Movable Bridge; Electric. (Superseding Lock, Drawbridge; Electric)

An electric lock used in connection with a movable bridge to prevent its operation until released.

Lock, Rail; Movable Bridge. (Superseding Lock, Rail; Drawbridge)

A mechanical device used to insure that the movable bridge rails are in proper position for the movement of trains.

Lock, Switch; Electric. (Asterisk deleted—no change in definition)

Lock, Switch Lever; Electric. (Asterisk deleted—no change in definition)

Locking, Approach. (Superseding Locking, Approach; Electric)

Electric locking effective while a train is approaching, within a specified distance, a signal displaying an aspect to proceed, and which prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the movement of any interlocked or electrically locked switch, movable point frog, or derail in the route governed by the signal, and which prevents an aspect to proceed from being displayed for any conflicting route. (I.C.C.)

Locking, Approach; Electric. (Superseded by Locking, Approach)

Locking, Electric. (Revision)

The combination of one or more electric locks and controlling circuits by means of which levers of an interlocking machine, or switches or other units operated in connection with signaling and interlocking, are secured against operation under certain conditions, such as:

1. Approach locking.*
2. Indication locking.*
3. Switch lever locking.*
4. Time locking.*
5. Traffic locking.*

Locking Face. (New)

See definition for Face, Locking.

Locking, Indication. (Superseding Locking, Indication; Electric)

Electric locking which prevents manipulation of levers that would result in an unsafe condition for a train movement if a signal, switch, or other operative unit fails to make a movement corresponding to that of its controlling lever, or which directly prevents the operation of a signal, switch, or other operative unit, in case another unit which should operate first fails to make the required movement. (I.C.C.)

Locking, Indication; Electric. (Superseded by Locking, Indication)

Locking, Latch. (Revision)

See definition for Locking, Latch-Operated.

Locking, Latch-Operated. (New)

The mechanical locking of an interlocking machine which is actuated by means of the lever latch. (I.C.C.)

Locking, Lever. (Revision)

See definition for Locking, Lever-Operated.

Locking, Lever-Operated. (New)

The mechanical locking of an interlocking machine which is actuated by means of the lever. (I.C.C.)

* For the sake of brevity, the word "electric" is commonly omitted when a particular kind of electric lock or electric locking is mentioned.

Locking, Mechanical. (Revision)

An arrangement of locking bars, dogs, tappets, cross-locking and other apparatus by means of which the interlocking is effected between the levers of an interlocking machine and so interconnected that their movements must succeed each other in a predetermined order. (I.C.C.)

Locking, Movable Bridge. (New)

The rail locks, bridge locks, bolt locks, circuit controllers, and electric locks used in providing interlocking protection at a movable bridge. (I.C.C.)

Locking, Route. (Superseding Locking, Route; Electric)

Electric locking, effective when a train passes a signal displaying an aspect for it to proceed, which prevents the movement of any switch, movable point frog, or derail in advance of the train within the route entered. It may be so arranged that as a train clears a track section of the route, the locking affecting that section is released. (I.C.C.)

Locking, Route; Electric. (Superseded by Locking, Route)*Locking, Section.* (Superseding Locking, Section; Electric—with no change in the definition)*Locking, Switch Lever; Electric.* (Asterisk deleted—no change in definition)*Locking, Time.* (Superseding Locking, Time; Electric)

A method of locking, either mechanical or electrical, which, after a signal has been caused to display an aspect to proceed, prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the operation of any interlocked or electrically locked switch, movable point frog, or derail in the route governed by that signal, and which prevents an aspect to proceed from being displayed for any conflicting route. (I.C.C.)

Locking, Time; Electric. (Superseded by Locking, Time)*Locking, Traffic.* (Superseding Locking, Traffic; Electric)

Electric locking which prevents the manipulation of levers or other devices for changing the direction of traffic on a section of track while that section is occupied or while a signal displays an aspect for a movement to proceed into that section. (I.C.C.)

Locking, Traffic; Electric. (Superseded by Locking, Traffic)*Machine, Centralized Traffic Control.* (Revision)

A control machine for operation of a specific type of traffic control system of signals and switches.

Machine, Control. (New)

An assemblage of manually operated levers or other devices for the control of signals, switches or other units, without mechanical interlocking, usually including a track diagram with indication lights.

Machine, Control; All-Relay Interlocking. (Revision)

See definition for *Machine, Control*.

Machine, Interlocking. (New)

An assemblage of manually operated levers or equivalent devices, for the control of signals, switches or other units, and including mechanical or circuit locking or both to establish proper sequence of movements.

Machine, Interlocking; Electric. (Revision)

An interlocking machine for the control of electrically operated functions.

Machine, Interlocking; Electro-Mechanical. (Revision)

An interlocking machine for the control of both power and mechanically operated functions.

Machine, Interlocking; Electro-Pneumatic. (Revision)

An interlocking machine for the control of electro-pneumatically operated functions.

Machine, Interlocking; Mechanical. (Revision)

An interlocking machine for the control of mechanically operated functions.

Machine, Interlocking; Power. (Term and definition to be deleted)*Machine, Interlocking; Table.* (Revision)

An interlocking machine for the control of power-operated functions and designed for mounting on a table or desk.

Machine, Switch. (Revision)

See definition for *Movement, Switch-and-Lock*.

Magnet, Track. (New)

See definition for *Element, Roadway*.

Manual Interlocking. (New)

See definition for *Interlocking, Manual*.

Movable Bridge Circuit Controller. (Superseding Drawbridge Circuit Controller)

See definition for *Controller, Circuit; Movable Bridge*.

Movable Bridge Coupler. (Superseding Drawbridge Coupler)

See definition for *Coupler, Movable Bridge*.

Movable Bridge Lock. (Superseding Drawbridge Lock)

See definition for Lock, Movable Bridge.

Movable Bridge Locking. (New)

See definition for Locking, Movable Bridge.

Movement, Facing. (New)

The movement of a train over the points of a switch which face in a direction opposite to that in which the train is moving. (I.C.C.)

Movement, Switch-and-Lock. (Revision of Switch-and-Lock Movement)

A device, the complete operation of which performs the three functions of unlocking, operating, and locking a switch, movable point frog, or derail. (I.C.C.)

Movement, Trailing. (New)

The movement of a train over the points of a switch which face in the direction in which the train is moving. (I.C.C.)

Movements, Conflicting. (New)

Movements over conflicting routes. (I.C.C.)

Open Wire Line. (New)

See definition for Line, Open Wire.

Operator, Control. (New)

An employee assigned to operate the control machine of a traffic control system. (I.C.C.)

Opposing Signals. (New)

See definition for Signals, Opposing.

Opposing Train. (New)

See definition for Train, Opposing.

Phantom Signal Aspect. (New)

See definition for Aspect, Phantom Signal.

Piece, Driving. (New)

A crank secured to a locking shaft by means of which horizontal movement is imparted to a longitudinal locking bar. (I.C.C.)

Piece, Driving; Detector Bar. (New)

A device secured to a detector bar to which the driving rod is attached.

Plate, Top. (Mechanical Locking) (New)

A metal plate secured to a locking bracket to prevent the cross-locking from being forced out of the bracket. (I.C.C.)

Plate, Top; Relay. (New)

That portion of a shelf or wall type relay to which the magnetic structure and contact elements are attached and which forms a part of the relay enclosure.

Plunger, Facing Point Lock. (Revision)

That part of a facing point lock which secures the lock rod to the plunger stand when the switch is locked. (I.C.C.)

Point, Clearance. (Revision)

The location on a turnout at which the carrier's specified clearance is provided between tracks. (I.C.C.)

Point, Controlled. (New)

A location where signals or other functions or both of a traffic control system are controlled from the control machine. (I.C.C.)

Point, Fouling. (Revision)

The location on a turnout back of the frog at which insulated joints or derails are placed at or beyond clearance point.

Point, Stop Indication. (New)

As applied to an automatic train stop or train control system without the use of roadway signals, a point where a signal displaying an aspect requiring a stop would be located. (I.C.C.)

Position, De-energized. (New)

The position assumed by the moving member of an electromagnetic device when the device is deprived of its operating current. (I.C.C.)

Position, False Restrictive. (New)

See definition for Aspect, False Restrictive.

Power Interlocking Machine. (Term and cross-reference to be deleted)*Principle, Closed Circuit.* (New)

The principle of circuit design where a normally energized electric circuit which, on being interrupted or de-energized, will cause the controlled function to assume its most restrictive condition. (I.C.C.)

Protection, Cross. (Revision)

An arrangement to prevent the improper operation of a signal, switch, movable point frog, or derail as the result of a cross in electrical circuits. (I.C.C.)

Rail Joint Bond. (New)

See definition for Bond, Rail Joint.

Ramp. (Train Control) (New)

See definition for Element, Roadway.

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Receiver. (Train Control) (Revision)

A device on a locomotive, so placed that it is in position to be influenced inductively or actuated by an automatic train stop, train control, or cab signal roadway element. (I.C.C.)

Relay Plate Top. (New)

See definition for Plate, Top; Relay.

Relay, Thermal. (Revision)

A timing relay whose contacts are actuated by the heating effect of current flowing through its controlling element.

Relay, Time Element. (Revision)

See definition for Relay, Timing.

Relay, Timing. (New)

A relay which will not close its front contacts or open its back contacts, or both, until the expiration of a definite time interval after the relay has been energized. (I.C.C.)

Relayed Cut-Section. (New)

See definition for Cut-Section, Relayed.

Release, Time. (Revision)

A device used to prevent the operation of an operative unit until after the expiration of a predetermined time interval after the device has been actuated. (I.C.C.)

Release Value. (New)

See definition for Value, Release.

Reset. (Revision)

See definition for Device, Reset.

Reset Device. (New)

See definition for Device, Reset.

Restoring Feature. (New)

See definition for Feature, Restoring.

Roadway Signal. (New)

See definition for Signal, Fixed.

Rocker. (New)

See definition for Link, Rocker.

Rod, Lock. (Revision)

A rod, attached to the front rod or lug of a switch, movable point frog, or derail, through which a locking plunger may extend when the switch points or derail are in the normal or reverse position. (I.C.C.)

Rod, Up-and-Down. (Revision)

A rod used for connecting the semaphore arm to the operating mechanism of a signal. (I.C.C.)

Roundel. (Revision)

A glass or similar product, usually circular in shape, used in lens or reflector assemblies for producing color or for mechanical protection of critical parts, or for spreading or deflecting the projected light beam into a pattern, dependent upon the design. It may be clear or colored as required.

Route, Interlocked. (New)

A route within interlocking limits. (I.C.C.)

Route Locking. (Superseding Electric Route Locking)

See definition for Locking, Route.

Routes, Conflicting. (New)

Two or more routes, opposing, converging, or intersecting, over which movements cannot be made simultaneously without possibility of collision. (I.C.C.)

Section, Dead. (New)

A section of track, either within a track circuit or between two track circuits, the rails of which are not part of a track circuit. (I.C.C.)

Section Locking. (Superseding Electric Section Locking)

See definition for Locking, Section.

Sectionalizing Switch. (New)

See definition for Switch, Sectionalizing.

Semaphore Arm Spectacle. (New)

See definition for Spectacle, Semaphore Arm.

Separate Return Circuit. (Revision)

See definition for Circuit, Line; Double-Wire.

Sheet, Locking. (Revision)

A description in tabular form of the locking operations in an interlocking machine. (I.C.C.)

Shoe. (New)

See definition for Receiver.

Shoe, Latch. (Revision)

The casting by means of which the latch rod and the latch block are held to a lever of a mechanical interlocking machine. (I.C.C.)

Shunt. (Revision)

A by-path in an electrical circuit. (I.C.C.)

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Shunt Fouling Circuit. (New)

See definition for Circuit, Shunt Fouling.

Shunt Wire. (New)

See definition for Wire, Shunt.

Signal, Roadway. (New)

See definition for Signal, Fixed.

Signal, Slotted Mechanical. (New)

A mechanically operated signal with an electromagnetic device inserted in its operating connection to provide a means of controlling the signal electrically as well as mechanically. (I.C.C.)

Signal, Switch. (Superseding Signal, Switch; Electric—with no change in definition)*Signal, Three-Position.* (Revision)

A signal arm arranged to give three aspects.

Signal, Two-Position. (Revision)

A signal arm arranged to give two aspects.

Signals, Opposing. (New)

Roadway signals which govern movements in opposite directions on the same track. (I.C.C.)

Slotted Mechanical Signal. (New)

See definition for Signal, Slotted Mechanical.

Spectacle, Semaphore Arm. (New)

That part of a semaphore arm which holds the roundels and to which the blade is fastened. (I.C.C.)

SS Protection. (Revision)

An arrangement of circuits whereby proceed aspects of a signal cannot be displayed unless the switch and its controlling lever or equivalent device are in corresponding position.

Station, Control. (New)

The place where the control machine of a traffic control system is located. (I.C.C.)

Stop. (Mechanical Locking) (New)

As applied to mechanical locking, a device secured to locking a bar to limit its movement. (I.C.C.)

Stop Indication Point. (New)

See definition for Point, Stop Indication.

Stopping Distance. (New)

See definition for Distance, Stopping.

Swing Dog. (New)

See definition for Dog, Swing.

Switch, Acknowledger or Forestalling. (Revision)

See definition for Device, Acknowledging.

Switch-and-Lock Movement. (Revision)

See definition for Movement, Switch-and-Lock.

Switch, Electro-Pneumatic. (New)

A track switch operated by an electro-pneumatic switch-and-lock movement.

Switch, Facing Point. (Revision)

A track switch, the points of which face traffic approaching in the direction for which the track is signaled.

Switch, Hand-Operated. (New)

A non-interlocked switch which can only be operated manually. (I.C.C.)

Switch, Interlocked. (New)

A track switch within the interlocking limits, the control of which is interlocked with other functions of the interlocking.

Switch Machine. (Revision)

See definition for Movement, Switch-and-Lock.

Switch, Sectionalizing. (New)

A switch for disconnecting a section of an electrical circuit from the source of energy. (I.C.C.)

Switch, Spring. (Revision)

A track switch equipped with a spring device which forces the points to their original position after being trailed through and holds them under spring compression.

Switch, Trailing Point. (Revision)

A track switch, the points of which face away from traffic approaching in the direction for which the track is signaled.

**System, Automatic Block Signal.* (Superseding System, Automatic Block—with no change in definition)

* Under revision for Standard Code.

System, Automatic Train Control. (Revision)

A system so arranged that its operation will automatically result in the following:

A full service application of the brakes which will continue either until the train is brought to a stop, or, under control of the engineman, its speed is reduced to a predetermined rate.

When operating under a speed restriction, an application of the brakes when the speed of the train exceeds the predetermined rate and which will continue until the speed is reduced to that rate.

(I.C.C.)

System, Automatic Train Stop. (New)

A system so arranged that its operation will automatically result in the application of the brakes until the train has been brought to a stop. (I.C.C.)

System, Traffic Control. (New)

A block signal system under which train movements are authorized by block signals whose indications supersede the superiority of trains for both opposing and following movements on the same track. (I.C.C.)

Terminal, Initial. (New)

The starting point of a locomotive for a trip.

Time, Acknowledging. (New)

As applied to an intermittent automatic train stop system, a predetermined time within which an automatic brake application may be forestalled by means of the acknowledging device. (I.C.C.)

Time, Delay. (New)

As applied to an automatic train stop or train control system, the time which elapses after an automatic brake application is initiated until the brakes start to apply. (I.C.C.)

Time Element Relay. (Revision)

See definition for Relay, Timing.

Time Locking. (Superseding Electric Time Locking)

See definition for Locking, Time.

Timing Relay. (New)

See definition for Relay, Timing.

Top Plate. (Mechanical Locking) (New)

See definition for Plate, Top.

Track Element. (Revision)

See definition for Element, Roadway.

Track Magnet. (New)

See definition for Element, Roadway.

Traffic Control System. (New)

See definition for System, Traffic Control.

Traffic Locking. (Superseding Electric Traffic Locking)

See definition for Locking, Traffic.

Trailing Movement. (New)

See definition for Movement, Trailing.

Train, Opposing. (New)

A train, the movement of which is in a direction opposite to and toward another train on the same track. (I.C.C.)

Trip Arm. (New)

See definition for Element, Roadway.

Trunking. (Revision)

A casing used to protect electrical conductors. (I.C.C.)

Trunnion. (Revision)

A cylindrical projection supporting a revolving part. (I.C.C.)

Value, Release. (New)

The electrical value at which the movable member of an electromagnetic device will move to its de-energized position. (I.C.C.)

Valve, Electro-Pneumatic. (Revision)

A valve electrically operated which, when operated, will permit or prevent passage of air. (I.C.C.)

Weatherproof Wire. (Weather resisting) (Superseding Weatherproof Wire)

See definition for Wire, Weatherproof. (Weather resisting)

Whistle, Acknowledging. (Revision)

An air-operated whistle which is sounded when the acknowledging device is operated or when a more restrictive cab signal is displayed.

Wire, Shunt. (New)

A wire forming part of a shunt circuit. (I.C.C.)

Wire, Weatherproof. (Weather resisting) (Superseding Wire, Weatherproof)

A metallic conductor, either solid or stranded, having two or more separate fibrous coverings saturated with a weather-resisting compound of comparatively low dielectric strength, usually of an asphaltic type.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Instructions for Light and Motor Semaphore Signals)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

LIGHT AND SEMAPHORE SIGNALS*

1951

These instructions apply to the installation, maintenance and test of light and semaphore signals. They set forth general requirements representing recommended practice.

General.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Each circuit, the functioning of which affects the safety of train operation, must be kept free of any ground or combination of grounds as instructed. In no case shall a flow of current be permitted which is equal to or in excess of 75 per cent of the release value of any relay or other electromagnetic device in the circuit.

3. Each wire must be tagged or otherwise marked so it can be identified at each terminal. Nomenclature must correspond to that of the circuit plan. Tags or other marks of identification in instrument cases and apparatus housings must be made of insulating material. Wires, tags, or other markings must not interfere with moving parts of apparatus.

4. Doors, covers and fastenings must be kept in good condition, with suitable gaskets in place.

5. Outdoor signal and instrument housings must be locked except signal mechanism housings at interlockings where maintenance forces are continuously on duty.

6. Parts which fail to perform their intended functions must be promptly adjusted, repaired or replaced.

7. Defective reflectors, lenses, roundels or cover glasses must be promptly replaced.

8. Action must be taken when necessary to prevent improper indications due to reflection of external light.

9. Mast must be vertical, mounted on suitable support and securely fastened. Signal must be aligned to display the best possible aspect for approaching trains.

10. Ladder, hand railing and platform must be kept in good condition and securely fastened.

* The term "as instructed" as used herein refers to individual railroad instructions.

General.—Continued.

11. Signal blades, lenses, reflectors, roundels, cover glasses and lamps must be cleaned as instructed. Where practicable, signal lenses, reflectors and roundels should be cleaned without removing incandescent lamp or disturbing adjustment of light unit.

12. Housings must be kept clean and must not be used for storing material, tools or supplies unless special provision is made. They should not be opened in severe or stormy weather, except when conditions require.

13. Bolts, nuts, pins and cotters of proper size and type must be kept in place, nuts kept tight and cotters properly spread.

14. Paint must be applied as often as required. Rusty surfaces must be cleaned before painting. Paint must not be applied to padlocks, threads of screw jaws, adjusting screws, or gaskets.

15. Inspections and tests must be made and results recorded as instructed, and values maintained in accordance with the Table of Operating Characteristics for the type of signal tested.

16. Manufacturer's instructions must be followed unless they conflict with general or detailed instructions, in which case proper authority must be consulted for correct procedure.

17. Operating mechanisms, when placed in service, must meet shop requirements specified in Table of Operating Characteristics for the particular type of signal.

18. Operating mechanisms not meeting field requirements specified in Table of Operating Characteristics must be removed from service as promptly as possible and defects noted on repair tag, Form 7018, Manual Part 124.

19. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps, Manual Part 120.

Color light signal—searchlight type.

20. Working voltage of operating mechanism must be maintained as closely as practicable to rated voltage. Where separate armature and field windings are used, low current in one element must not be compensated for by increasing the current in the other element above its rated limit.

21. Operating mechanism and reflector unit must be securely fastened in place.

22. Changes in the internal parts of the signal, including the lens and lamp receptacle, must not be made from their original settings.

23. Where deflecting prisms are used, care must be exercised to see that they are assembled and maintained to spread the light in the proper direction.

Color light (other than searchlight types), position light and color position light signals.

24. Changes in the internal parts of the signal, including the lens and lamp receptacle, must not be made from their original settings, except that lamp receptacle may be changed or reset where provision has been made for proper focusing.

25. Door or cover of lamp unit of color light signal must be kept closed when train is approaching.

26. Where deflecting prisms are used, care must be exercised to see that they are assembled and maintained to spread the light in the proper direction.

Semaphore signals.

27. At least $\frac{1}{2}$ inch clearance must be provided between the semaphore arm and any object that may interfere with its operation.

28. Semaphore spectacle casting must rest against the stop provided for that purpose, allowing slot-arms and vertical connections to be free from downward pressure when in the most restrictive position.

29. A minimum clearance of $\frac{3}{4}$ inch must be maintained between the semaphore bearing and any passing part of the semaphore spectacle (except hub).

30. Semaphore signals must not be placed in service until bearings have been cleaned, and all oil, dirt and grease removed from the armature and poles of slot magnets and gears, all parts lubricated, and electrical torque tests made when practicable.

31. Semaphore shaft bearings must be packed with lubricant specified by the manufacturer, which must be kept in a semi-fluid state, when necessary, by the addition of a small amount of Specification 102 or 103 oil, Manual Part 106 or 107.

32. Clutch between motor shaft and pinion gear on signals so equipped must be lubricated as instructed.

33. Bearings and movable parts except those covered in Instructions 31 and 32 must be lubricated with Specification 102 or 103 oil, Manual Part 106 or 107, as instructed.

34. Movable and fixed member of slot or retaining device must be kept free from grease, oil and dirt.

35. Circuit controller contacts must be kept clean and in proper adjustment. Lintless cloth or chamois should be used for cleaning and must be free from abrasives.

36. Buffing or snubbing of signal must be effective to eliminate undue strain on mechanism and buffing device must be so maintained as not to cause signal to display a less restrictive aspect than intended.

37. Where an electrical snubbing device is used, tests must be made as instructed to determine that the device is effective. Signal should travel from the 90 to the zero degree position in approximately 8 seconds when control circuit is opened.

38. Armature of signal motor must not have excessive lost motion in bearings and the clearance between rotating and stationary parts must be adequate to provide proper operation.

39. Commutator must be smooth, clean and have a glossy appearance. To clean, lift brushes from commutator and use chamois or cloth free from lint and abrasives, moistened, if necessary, with Specification 102 or 103 oil, Manual Part 106 or 107, and then wipe commutator dry with dry chamois or cloth. Abrasives or files must not be used on commutators.

40. Brushes must be kept clean, fitted to commutator, free in brush holder or brush holder free on stud. Springs must be in place and so maintained that brushes will have proper bearing and pressure. When installing new brushes they should be placed in position and carefully seated on the commutator by placing No. 000 or finer sandpaper under the brush with smooth side against the commutator and while pressing brush oscillate sandpaper with commutator. Burrs must be removed from the brush. When finished, all sand and dust must be removed.

Semaphore signals.—Continued.

41. Counters, when used, must be adjusted to correctly register operation of mechanism. Counters must not be oiled.

42. Chains and sprockets where used must be cleaned when necessary and coated lightly with a light grease.

43. Motor clutch where used must be adjusted to slip as instructed.

44. In starting tests the signal must be in its most restrictive position and motor circuit open. Connections must be made as shown in Fig. 1, and motor circuit closed, allowing motor to operate and hold clear device to become effective.

45. Motor must be tested while signal is clearing by reducing voltage until armature rotates slowly. If motor does not run smoothly at slow speed, it is evidence of a faulty condition which must be corrected.

46. Test for minimum clearing values must be made by adjusting voltage until signal just clears and holds.

47. Test for release values of hold clear device must be made by increasing voltage until normal operating value is obtained, then reducing voltage gradually until hold clear device releases.

48. In making tests on 45-degree position of three-position signals, the 90-degree operating circuit must be opened to prevent the signal clearing beyond the 45-degree position.

49. In making tests on 90-degree position of three-position signals, the 45-degree operating circuit must be closed and the instruments connected in the 90-degree circuit.

Method of making shop and field electrical torque tests of motor semaphore signals in which the motor is operated backward by the semaphore torque.

50. For direct current signals Styles T-2, L, 4 and 2-A, connect an adjustable resistance and ammeter in series with the motor, gradually reduce the resistance until the motor will just move the arm upward. Just before the arm reaches the 45-degree position, quickly insert sufficient resistance to permit the motor, with snubbing circuit open and moved by the arm, to start backward. With Styles T-2 and L signals, hold clear armature must be fixed in the de-energized position.

(a) The current which will permit it to start backward from a given position should be not less than 50 per cent of the current required to move it to that position. If this current is less than 50 per cent, inspection must be made to determine that brush pressure is not excessive, that proper clearance exists between motor armature and pole faces, that shaft and gears are lubricated and working freely and that there is no binding in circuit controller.

(b) The same test must be made starting just before arm reaches the 90-degree position.

51. For alternating current signals Styles T-2 and 2-A, supply sufficient voltage to the motor for any given semaphore position to just cause the motor rotor to revolve one or two times, then quickly reduce the voltage to such a value that the rotor turns back one or two times. Care must be taken to see that these readings are taken at approximately the same semaphore position and within one or two revolutions of the motor rotor.

Sept. 1951]

Committee V—Contracts and Instructions

Method of making shop and field electrical torque tests of motor semaphore signals in which the motor is operated backward by the semaphore torque.—Continued.

(a) The voltage which will permit the motor to just turn backward should be not less than 80 per cent for Style T-2 signals and 65 per cent for Model 2-A signals of the voltage that will just cause the motor to move the arm upward. If this voltage is less than the percentage values specified, inspection must be made to determine that proper clearance exists between the motor armature and the stator, that the shaft and gears are lubricated and working freely, and that there is no binding in the circuit controller or any other moving parts.

(b) The same test must be made at several angular positions of the semaphore, including just before the arm reaches the 45-degree and the 90-degree positions.

PAGES 5 TO 12, INCLUSIVE OF MANUAL PART 54—NO CHANGE EXCEPT THE FOLLOWING TO BE ADDED AS THE LAST COLUMNS UNDER SHOP AND FIELD REQUIREMENTS IN TABLE OF OPERATING CHARACTERISTICS OF MODEL 2-A SIGNALS APPEARING ON PAGE 8:

Shop Requirements

Minimum
Air Gap of
Hold Clear
Armature

Inch

0.023

0.023

0.023

0.023

0.023

0.023

—

—

—

—

0.50

0.50

Field Requirements

Minimum
Air Gap of
Hold Clear
Armature

Inch

0.015

0.015

0.018

0.018

0.018

0.018

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0.438

0.438

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions 1 to 57, inclusive, of Instructions for Light and Motor Semaphore Signals, Manual Part 54.

(Revision of Instructions for Automatic Block Signal Systems)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

AUTOMATIC BLOCK SIGNAL SYSTEMS*

1951

These instructions apply to the installation, maintenance and test of automatic block signal systems. They set forth general requirements representing recommended practice.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Before removing rails, switch points or frogs, protecting signals must be secured to display their most restrictive indication. Signals must not be restored to normal operation until tests have been made and it is known that they function as intended and that the track is safe for train operation.

3. Dragging equipment or landslide-detecting devices and other similar protective devices must be maintained and tested as instructed.

4. In case of severe storm, inspection must be made as soon as practicable, and trouble corrected as instructed.

5. Each circuit, the functioning of which affects the safety of train operation, except circuit which includes any track rail must be kept free of any ground or combination of grounds as instructed. In no case shall a flow of current be permitted which is equal to or in excess of 75 per cent of the release value of any relay or other electromagnetic device in the circuit.

6. Each wire must be tagged or otherwise marked so it can be identified at each terminal. Nomenclature must correspond to that of the circuit plan. Tags or other marks of identification in instrument cases and apparatus housings must be made of insulating material. Wires, tags, or other markings must not interfere with moving parts of apparatus.

7. Outdoor signal and instrument housings must be locked. Time releases and electric locks must be locked or sealed. All locks or seals must be maintained as instructed.

8. Doors, covers and fastenings must be kept in good condition, with suitable gaskets in place.

9. Contacts must be kept clean and in proper adjustment as instructed.

10. Lightning arresters and made grounds must be properly connected, maintained and tested as instructed.

11. Movable parts must be kept clean, properly adjusted and lubricated as instructed.

12. Parts which fail to perform their intended functions must be promptly adjusted, repaired or replaced.

* The term "as instructed" as used herein refers to individual railroad instructions.

13. Housings must be kept clean and must not be used for storing material, tools or supplies unless special provision is made. They should not be opened in severe or stormy weather, except when conditions require.

14. Bolts, nuts, pins and cotters of proper size and type must be kept in place, nuts kept tight and cotters properly spread.

15. Paint must be applied as often as required. Rusty surfaces must be cleaned before painting. Paint must not be applied to padlocks, threads of screw jaws, adjusting screws, or gaskets.

16. Signal apparatus must be maintained as instructed so as to conform to established clearances for equipment.

17. Signals must be maintained and tested in accordance with Instructions for Light and Semaphore Signals, Manual Part 54.

18. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps, Manual Part 120.

19. Switch circuit controllers must be maintained and tested in accordance with Instructions for Switch Circuit Controllers, Manual Part 134.

20. Batteries must be maintained and tested in accordance with Instructions for Cells and Batteries, Manual Parts 7 and 14.

21. Track circuits must be maintained and tested in accordance with Instructions for Track Circuits, Manual Parts 8, 162 and 218.

22. Wire and cable must be maintained and handled in accordance with Instructions for Wire and Cable, Manual Part 190.

23. Relays must be maintained and tested in accordance with Instructions for Relays, Manual Parts 124 and 126.

24. Time releases and timing relays must be maintained and tested in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.

25. Rectifiers and motor-generators must be maintained and tested in accordance with Instructions for Rectifiers and Motor-Generators, Manual Part 68.

26. Insulated rail joints must be maintained and tested in accordance with Instructions for Insulated Rail Joints, Manual Part 133.

27. Ground resistance must be maintained and tests made in accordance with Instructions for Resistance of Made Grounds, Manual Part 61.

28. Insulation resistance tests must be made in accordance with Instructions for Insulation Resistance, Manual Part 130.

29. Spring switches must be maintained and tested in accordance with Instructions for Spring Switches, Manual Part 140.

30. Facing point locks applied to spring switches must be maintained and tested in accordance with Instructions for Facing Point Locks Applied to Spring Switches, Manual Part 159.

31. Reflector signs must be maintained in accordance with Instructions for Maintaining Reflector Signs, Manual Part 234.

32. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Automatic Block Signal Systems, Manual Part 102,

(Revision of Instructions for Time Releases Applied to Signal Apparatus)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

TIME RELEASES APPLIED TO SIGNAL APPARATUS*

1951

These instructions apply to the installation, maintenance and test of time releases applied to signal apparatus. They set forth general requirements representing recommended practice.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Parts which fail to perform their intended functions must be promptly adjusted, repaired or replaced.

3. The minimum release time setting of time releases should be more than the maximum time required for a train of minimum braking power to stop with a full service application of the brakes, before reaching a point where a stop is required.

4. The release time setting shall be the time required for a train to travel the distance between the approach signal and the point where a stop is required, at a speed not to exceed 30 miles per hour, plus a distance factor to provide additional time.

5. In territory where electric locks are applied to hand-operated switches, the release time setting shall be the time required for a train to travel the distance between the approach signal and the electric lock location, at a speed not to exceed 30 miles per hour, plus a distance factor to provide additional time.

6. The minimum release time setting shall be not less than the following:

(a) Where provided for signals controlling movements
at medium or higher speed..... 3 minutes.

(b) Where provided for signals controlling movements
at less than medium speed.....10 seconds.

7. The predetermined minimum release time setting must be shown on plans or marked on time release or timing relay.

8. The time setting must be maintained at not less than 90 per cent of the predetermined time interval.

9. Timing tests must be made periodically, as instructed.

10. Timing of electrically operated time releases must be made at service voltage.

11. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

* The term "as instructed" as used herein refers to individual railroad instructions.

12. Method for computing the release time setting where:

T = Time.

A = Distance between approach signal and point where stop is required and braking distance at maximum authorized speed is provided.

A¹ = Actual distance between first approach signal and the home signal.A² = Actual distance between the first and second approach signal.

B = Distance factor in feet approaching approach signal to provide additional time. (1,500 feet is considered a minimum for speed of 30 miles per hour.)

C = Feet per second at train speed not to exceed 30 miles per hour (1.467 × m.p.h.).

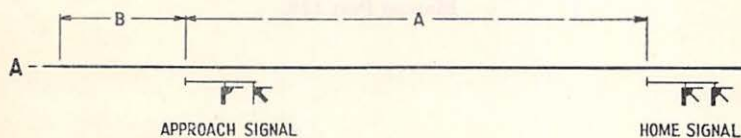
C¹ = Feet per second at train speed not to exceed 15 miles per hour (1.467 × m.p.h.).

D = Feet per second traveled at maximum speed for which first approach signal provides braking distance.

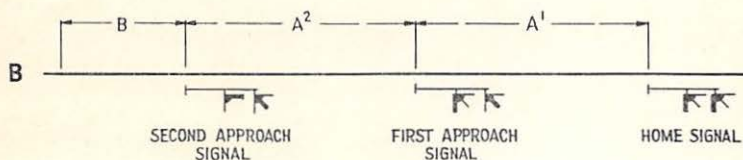
L = Actual distance between the electric lock and its protecting signal.

Note.—Where train speeds of less than 30 miles per hour or where physical conditions prevent trains from averaging 30 miles per hour, the time setting for train speed C in formula should be based on the distance traveled in feet per second at the average train speed attained.

13. Assumptions and examples:

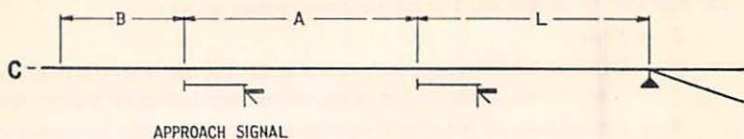


$$T = \frac{A+B}{C} = \frac{7500+1500}{44} = \frac{9000}{44} = 205 \text{ SECONDS (3 MINUTES 25 SECONDS)}$$

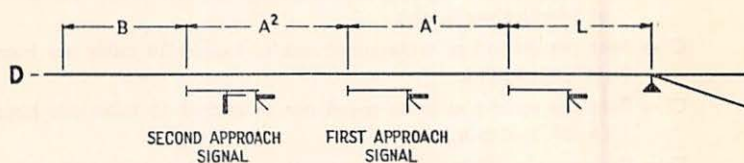


$$T = \frac{A^1+B}{C} + \frac{A^2}{D} = \frac{5000+1500}{44} + \frac{5350}{73} = \frac{6500}{44} + \frac{5350}{73} = 221 \text{ SECONDS (3 MINUTES 41 SECONDS)}$$

NOTE: WHERE MORE THAN TWO APPROACH SIGNALS ARE REQUIRED, THE FORMULA FOR COMPUTING THE RELEASE TIME SETTING SHOULD BE EXPANDED AS REQUIRED.



$$T = \frac{A+B}{C} + \frac{L}{C'} = \frac{7500 + 1500}{44} + \frac{500}{22} = 227 \text{ SECONDS (3 MINUTES 47 SECONDS)}$$



$$T = \frac{A^1+B}{C} + \frac{A^2}{D} + \frac{L}{C'} = \frac{5000 + 1500}{44} + \frac{5350}{73} + \frac{500}{22} = 243 \text{ SECONDS (4 MINUTES 3 SECONDS)}$$

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Time Releases Applied to Signal Apparatus,
Manual Part 128.

(Revision of Instructions for Switch Circuit Controllers)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

SWITCH CIRCUIT CONTROLLERS*

1951

These instructions apply to the installation, maintenance and test of switch circuit controllers. They set forth general requirements representing recommended practice.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Circuit controllers must be securely fastened in place.

3. Circuit controller connected at the point to switch, derail, or movable point frog, must be so maintained that its contacts will not be in position corresponding to switch point closure when switch point is open $\frac{1}{4}$ inch or more.

4. Circuit controller operated by an independently operated derail, other than switch point type, must be so maintained that the normally open contacts will remain closed and normally closed contacts will remain open when controller connecting rod movement exceeds 1 inch toward non-derailing position.

5. Circuit controller operated by switch-and-lock movement must be so maintained that the normally open contacts will remain closed and normally closed contacts will remain open until the locking dog has entered the locking notch of the lock rod $\frac{1}{2}$ inch or more.

6. Circuit controller operated by a facing point lock, independent of the switch operating device, must be so maintained that the normally open contacts will remain closed and normally closed contacts will remain open until the locking plunger has extended through the lock rod $\frac{1}{2}$ inch or more.

7. Tests must be made as instructed to determine that:

(a) Movement of train over switch, derail, or movable point frog will not cause contacts to open or close improperly.

(b) With the switch fully open or locking plunger fully withdrawn, circuit controller contacts will not open or close improperly.

(c) Track shunting circuit through circuit controller contacts meets resistance requirements.

8. Contacts must be kept clean and in proper adjustment as instructed. Contact opening must be not less than $\frac{1}{16}$ inch when open.

9. Movable parts must be kept clean, properly adjusted and lubricated as instructed.

* The term "as instructed" as used herein refers to individual railroad instructions.

10. Parts which fail to perform their intended functions must be promptly adjusted, repaired or replaced.

11. Bolts, nuts, pins and cotters of proper size and type must be kept in place, nuts kept tight and cotters properly spread.

12. Movable parts must be lubricated as instructed.

13. Covers and fastenings must be kept in good condition with suitable gaskets in place.

14. All padlocks or seals must be maintained as instructed.

15. Ventilator screens must be in place and kept free of paint or other obstruction.

16. Wire and cable entrances must be properly sealed to prevent entrance of moisture, rodents and insects.

17. Threads of rods, jaws and bolts must be kept clean and properly lubricated.

18. Paint must be applied as often as required. Rusty surfaces must be cleaned before painting. Paint must not be applied to padlocks, threads of screw jaws, adjusting screws, or gaskets.

19. Circuit controllers removed from service for repairs must be returned with full information as required on repair tag Form 7018, Manual Part 124, or as instructed.

20. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded

Instructions for Switch Circuit Controllers, Manual Part 134.

(Revision and Consolidation of Instructions for Automatic
Interlocking and Instructions for Interlocking)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

INTERLOCKINGS*

1951

These instructions apply to the installation, maintenance and test of interlockings. They set forth general requirements representing recommended practice.

General.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Before removing rails, switch points or frogs, protecting signals must be secured to display their most restrictive indication. Signals must not be restored to normal operation until tests have been made and it is known that they function as intended and that the track is safe for train operation.

3. When mechanical locking of interlocking machine is to be changed or removed from machine, or locking becomes disarranged or broken, proper measures must be taken as instructed to protect train movements until interlocking is restored to normal operation.

4. Dragging equipment or landslide-detecting devices and other similar protective devices must be maintained and tested as instructed.

5. In case of severe storm, inspection must be made as soon as practicable, and trouble corrected as instructed. Where snow-melting open flame devices are used, care must be exercised to prevent damage to interlocking apparatus.

6. Each circuit, the functioning of which affects the safety of train operation, except circuit which includes any track rail must be kept free of any ground or combination of grounds as instructed. In no case shall a flow of current be permitted which is equal to or in excess of 75 per cent of the release value of any relay or other electromagnetic device in the circuit.

7. Each wire must be tagged or otherwise marked so it can be identified at each terminal. Nomenclature must correspond to that of the circuit plan. Tags or other marks of identification in instrument cases and apparatus housings must be made of insulating material. Wires, tags, or other markings must not interfere with moving parts of apparatus.

* The term "as instructed" as used herein refers to individual railroad instructions.

General.—Continued.

8. Outdoor signal and instrument housings must be locked, except signal mechanism housings where maintenance forces are continuously on duty. Power interlocking machine cabinets, time releases, and electric locks exposed on interlocking machines must be locked or sealed. All locks or seals must be maintained as instructed.

9. Doors, covers and fastenings must be kept in good condition, with suitable gaskets in place.

10. Contacts must be kept clean and in proper adjustment as instructed.

11. Lightning arresters and made grounds must be properly connected, maintained and tested as instructed.

12. Movable parts must be kept clean, properly adjusted and lubricated as instructed.

13. Parts which fail to perform their intended functions must be promptly adjusted, repaired or replaced.

14. Housings must be kept clean and must not be used for storing material, tools or supplies unless special provision is made. They should not be opened in severe or stormy weather, except when conditions require.

15. Bolts, nuts, dowel pins, pins and cotters of proper size and type must be kept in place, nuts and dowel pins kept tight and cotters properly spread.

16. Paint must be applied as often as required. Rusty surfaces must be cleaned before painting. Paint must not be applied to padlocks, threads of screw jaws, adjusting screws, or gaskets.

17. Signal apparatus must be maintained as instructed so as to conform to established clearances for equipment.

18. Threads of rods, jaws and bolts must be kept clean and properly lubricated.

19. Switches, movable point frogs and split point derails must be so maintained that they cannot be locked if the switch point is prevented by an obstruction from closing to within $\frac{1}{4}$ inch.

20. Point detector must be so maintained that when switch mechanism is locked in normal or reverse position, contacts cannot be opened by manually applying force at the closed switch point. Point detector circuit controller must be so maintained that the contacts will not assume the position corresponding to switch point closure if the switch point is prevented by an obstruction from closing to within $\frac{1}{4}$ inch.

21. Holes or notches in lock rods must have square edges and must not be more than $\frac{1}{16}$ inch larger than the locking bar or plunger.

22. Edges of locking dogs and rods of switch-and-lock movement or facing point lock must be maintained with not more than $\frac{1}{16}$ inch wear.

23. Batteries must be maintained and tested in accordance with Instructions for Batteries and Cells, Manual Parts 7 and 14.

24. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps, Manual Part 120.

25. Insulated rail joints must be maintained and tested in accordance with Instructions for Insulated Rail Joints, Manual Part 133.

26. Rectifiers and motor-generators must be maintained and tested in accordance with Instructions for Rectifiers and Motor-Generators, Manual Part 68.

27. Relays must be maintained and tested in accordance with Instructions for Relays, Manual Parts 124 and 126.

General.—Continued.

28. Time releases and timing relays must be maintained and tested in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.

29. Electric locks must be maintained in accordance with Instructions for Electric Locks for Interlocking Machines, Manual Part 23.

30. Signals must be maintained and tested in accordance with Instructions for Light and Semaphore Signals, Manual Part 54.

31. Switch circuit controllers must be maintained and tested in accordance with Instructions for Switch Circuit Controllers, Manual Part 134.

32. Track circuits must be maintained and tested in accordance with Instructions for Track Circuits, Manual Parts 8, 162 and 218.

33. Wire and cable must be maintained and handled in accordance with Instructions for Wire and Cable, Manual Part 190.

34. Ground resistance must be maintained and tests made in accordance with Instructions for Resistance of Made Grounds, Manual Part 61.

35. Insulation resistance tests must be made in accordance with Instructions for Insulation Resistance, Manual Part 130.

36. Spring switches must be maintained and tested in accordance with Instructions for Spring Switches, Manual Part 140.

37. Facing point locks applied to spring switches must be maintained and tested in accordance with Instructions for Facing Point Locks Applied to Spring Switches, Manual Part 159.

38. Electric locking must be tested in accordance with Instructions for Electric Locking, Manual Part 199.

39. Movable bridge locking must be maintained and tested in accordance with Instructions for Signal Protection for Movable Bridges, Manual Part 233.

40. Time recorder, where used, must be tested to determine that it operates properly.

41. Cross protection must be tested to determine that protective devices operate properly.

42. Restoring feature on power switches must be tested to determine that power will restore switch movements to normal or reverse position.

43. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

Mechanical locking.

44. The various parts of the locking bed, locking bed supports and tappet stop rail must be kept rigidly secured and properly aligned to provide free and effective operation.

45. Driving pieces, dogs, stops and trunnions must be kept properly secured to locking bars. Swing dogs must have full and free movement. Top plates must be in place and tight. Splices in longitudinal locking bars must be straight and properly made.

46. Locking faces must fit squarely against each other with a minimum engagement, when locked, of at least one-half the designed locking face.

47. Latch shoes, rocker links, rockers and quadrants must be maintained and tested to determine that lost motion will not permit the locking to release. Latch shoes, rocker links, and quadrants of S. & F. machines must be so maintained that locking will not release if a downward force not exceeding a man's

Mechanical locking.—Continued.

weight is exerted on the rocker while the lever is in the midstroke position, or the lever shoe leave its position on the rocker if the rocker is pushed to the right with the foot and at the same time the lever is forced to the left as far as it will go, making check during the complete stroke of the lever.

48. Locking bars in new locking must have full stroke as follows:

(a) Mechanical interlocking machine, S. & F. locking..... $1\frac{3}{4}$ inches.(b) Mechanical interlocking machine, Style A locking..... $\frac{7}{16}$ inch.

(c) Electro-mechanical interlocking machine, S. & F. locking.

1. Lever with full stroke having S. & F. driver..... $1\frac{3}{4}$ inches.2. Lever normally center having rack driver..... $2\frac{5}{8}$ inches.(d) Electro-mechanical interlocking machine, S. & F. miniature locking..... $1\frac{1}{16}$ inches.

(e) Electro-mechanical interlocking machine (Style A miniature locking).

1. Vertical locking..... $\frac{1}{4}$ inch.2. Horizontal locking..... $1\frac{1}{32}$ inch.(f) Power interlocking machine, S. & F. miniature locking..... $1\frac{1}{16}$ inches.

(g) Power interlocking machine (Style A miniature locking).

1. Vertical locking..... $\frac{1}{4}$ inch.2. Horizontal locking..... $1\frac{1}{32}$ inch.

(h) Table interlocking machines.

1. Type A.

(a) Vertical locking..... $\frac{7}{32}$ inch.(b) Horizontal locking..... $1\frac{1}{2}$ inches.2. Type TC..... $1\frac{1}{16}$ inches.

49. On mechanical interlocking machines the latch block adjustment must be as follows:

(a) Latch block must not lift more than $\frac{1}{8}$ inch above top of quadrant.(b) Latch block lift to permit operation of lever must be not less than $\frac{3}{4}$ inch.

50. Locking and connections must be so maintained that when a lever or latch is mechanically locked the following will be prevented:

(a) Mechanical machine.

1. Latch operated locking.

(a) On levers not fitted with electric locks, raising lever latch block so that bottom thereof is within $\frac{3}{8}$ inch from top of quadrant.(b) On levers fitted with electric locks, raising lever latch block so that bottom thereof is within $\frac{7}{16}$ inch from top of quadrant.

2. Lever operated locking.

(a) Moving lever latch block more than $\frac{3}{8}$ inch on top of quadrant.

Mechanical locking.—Continued.

(b) Electro-mechanical machine.

1. Lever moving in horizontal plane. Moving lever more than $\frac{3}{16}$ inch when in normal position or more than $\frac{7}{16}$ inch when in reverse position.

2. Lever moving in an arc. Moving lever more than 5 degrees, equivalent to $\frac{1}{4}$ inch movement of the latch on the quadrant.

(c) Power machine.

1. Latch operated locking. Raising lever latch block so that bottom thereof is within $\frac{7}{32}$ inch of top of quadrant.

2. Lever moving in horizontal plane. Moving lever more than $\frac{3}{16}$ inch when in normal position or more than $\frac{9}{16}$ inch when in reverse position.

3. Lever moving in an arc. Moving lever more than 3 degrees, equivalent to $\frac{7}{64}$ inch movement of the lever latch on quadrant.

51. On electro-mechanical interlocking machines, the locking between the electric and its mechanical levers must be so maintained that mechanical levers cannot be operated except when released by the electric levers.

52. When new locking is to be placed in service or a change in locking is made, a complete check and test must be made of the locking as follows:

(a) With all levers normal see that locking agrees with the dog chart.

(b) Levers must be tested to see that each lever when reversed and latch down, locks all other levers in the position as required by the locking sheet.

(c) Complete test of the locking from a signal layout or interlocking plan must be made as follows:

1. Test locking between switch, derail and movable point frog levers.

2. Test locking between facing point lock and switch, derail and movable point frog levers.

3. Set up each route and endeavor to reverse each signal lever that should be locked by that route; then reverse signal lever, governing movements over route and endeavor to operate each lever that should be locked by the signal lever; then restore lever to normal position and make similar test with lever for the opposing signal.

4. Where route or traffic levers are used, locking tests must be made as outlined for signal levers in Instruction 52-c-3.

5. Parallel routes or other routes must be set up and signal levers operated for movements in both directions on each route to determine that the locking of one route does not interfere with other routes.

6. These tests require that the lever latch must be fully down with lever in proper position.

Mechanical interlocking.

53. Cranks, compensators, and other mechanical connections must work freely, but must not have excessive lost motion. They must be kept clean, properly centered, lubricated and in alignment.

Mechanical interlocking.—Continued.

54. Pipe lines must be kept in good condition and in alignment. Tops of all pipe carrier foundations must be level and not less than 2 inches above the ground. All rollers must be free and all bases firmly attached to foundations.

55. Plunger of facing point lock must have at least 8-inch stroke when operated by its lever. It must pass through lock rod $\frac{1}{2}$ inch or more when lever is in locked position and must clear lock rod 1 inch when lever is in unlocked position. The end of the plunger must have square edges.

56. Bolt lock must be so maintained that signals governing movements over switch or derail cannot display a less restrictive aspect than Stop when derail is in derailing position, or when switch point is open $\frac{1}{4}$ inch or more when bolt lock is used in lieu of facing point lock, and $\frac{1}{2}$ inch or more when switch or derail is otherwise protected. Signal bar must be against the stop when signal lever is normal. Notches must have square edges.

57. Locking dog of switch-and-lock movement shall extend through lock rod $\frac{1}{2}$ inch or more in either normal or reverse position.

58. When necessary to disconnect a switch, derail or any other unit, it should be done at the crank nearest the unit.

Electro-pneumatic interlocking.

59. When necessary to work on operating mechanisms, energy must be cut off the control magnets by disconnecting the circuit until the work is completed.

60. Air compressor intakes must be kept clean and free from dirt and moisture. Intake must not be close to the ground, inside of buildings or where moisture accumulates. Nothing should be done which might obstruct or increase the resistance of air intakes.

61. Condensers, tanks, reservoirs and air distribution lines must be drained frequently to avoid overflow of condensation into branch lines and apparatus. Means of draining condensation out of distribution system must be provided and maintained at low points.

62. Special attention must be given to drainage of condensation from air systems throughout the period of the year when temperatures are above freezing so as to avoid interruptions during cold weather.

63. Air distribution systems must be so maintained that leakage in any section of the system will not exceed 1 pound in 3 minutes at normal pressure with all apparatus connected and at rest.

64. Inside of pipe and fittings must be kept free from iron cuttings, scale, dirt, paints or pipe joint compounds.

65. Air strainers used between air distribution system and air apparatus must be cleaned frequently to avoid air pressure reduction.

66. Oil used in piping system or internal parts of valves, cylinders and other apparatus, must be of a grade which will not disintegrate nor injure leather and similar packing.

67. Pick-up and release of valve magnets must be tested as instructed and values maintained within the limits recommended by manufacturer.

68. Valves and cylinders must be tested to determine that parts are clean, packing tight, air supply unrestricted and apparatus functions properly.

69. When necessary to clean or repair valves and cylinders they must be removed from service and the work performed as instructed.

Electric interlocking.

70. When necessary to work on operating mechanisms, energy must be cut off the motor. Where facilities are not provided to open motor circuit, motor brushes must be lifted and fuse at interlocking machine removed until the work on operating mechanism is completed.

71. Operating mechanism must be operated by hand after making adjustments to see that they operate properly and without undue strain on any part before being operated by power and then by power from the control point for checking operation after making adjustments.

72. Contactors must not be operated manually, except when out of service.

73. Commutator must be smooth, clean and have a glossy appearance. To clean, lift brushes from commutator and use chamois or cloth free from lint and abrasives, moistened, if necessary, with Specification 102 or 103 oil, Manual Part 106 or 107, then dry with chamois or cloth. Abrasives or files must not be used on commutators.

74. Brushes must be kept clean, fitted to commutator, free in brush holder, or brush holder free on stud. Springs must be in place and so maintained that brushes will have proper bearing and pressure. When installing new brushes they should be placed in position and carefully seated on the commutator by placing No. 000 or finer sandpaper under the brush with smooth side against the commutator, and while pressing brush oscillate sandpaper with commutator. Burrs must be removed from the brush. When finished, all sand and dust must be removed.

75. Friction clutch in operating mechanism must be adjusted in accordance with manufacturer's instructions.

76. Magnetic brake and overload relays must be checked for proper operation as instructed.

All-relay interlocking.

77. Where protection afforded by circuits is equivalent to mechanical locking, tests must be made in accordance with Instruction 52 in so far as they apply.

Automatic interlocking.

78. Tests must be made as instructed to determine that:

(a) A loss of shunt for 5 seconds or less will not permit an established route to be changed.

(b) When any track circuit between home signals on any route is occupied, home signals for all conflicting routes, and for the route occupied, cannot be cleared.

(c) Where protection afforded by circuits is equivalent to mechanical locking, tests must be made in accordance with Instruction 52 in so far as they apply.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Automatic Interlocking, Manual Part 59, and
Instructions for Interlocking, Manual Part 138.

(Revision of Instructions for Electric Locking)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

ELECTRIC LOCKING*

1951

These instructions apply to testing electric locking. They set forth general requirements representing recommended practice.

General.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

Approach relay.

3. Determine that the approach relay is de-energized when each track circuit in the approach section is shunted separately.

Approach locking.

4. Determine that after a signal has been cleared and with the approach relay de-energized and the signal restored to display the Stop indication, the route governed by that signal cannot be changed until after a predetermined time interval has elapsed.

Time locking.

5. Determine that after a signal has been cleared, the route governed by that signal cannot be changed until after the signal has been restored to display the Stop indication and a predetermined time interval has elapsed.

Indication locking.

6. Tests must be made to determine that:

(a) Locking is effective for levers or equivalent devices controlling signals until they display their most restrictive indication.

(b) Switches, movable point frogs and derails do not indicate before mechanism has locked in position corresponding with lever or equivalent device.

* The term "as instructed" as used herein refers to individual railroad instructions.

Route locking.

7. Determine that, where a combination of one or more electric locks or other units is used to lock switches or facing point locks, etc., the functions cannot be moved if any of the track circuits in the route are shunted or a predetermined time interval has not elapsed.

Traffic locking.

8. Determine that the direction of traffic cannot be changed while an aspect for a given direction is displayed for a train to proceed into that section or with any part of the section occupied.

Circuit locking.

9. Protection effected by means of circuits in lieu of mechanical locking must be tested to determine that switches or other units operated in connection with signaling and interlocking are secured against improper operation.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Electric Locking, Manual Part 199.

(Revision of Instructions for Signal Protection for Movable Bridges)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

SIGNAL PROTECTION FOR MOVABLE BRIDGES*

1951

These instructions apply to the installation, maintenance and test of signal protection for movable bridges. They set forth general requirements representing recommended practice.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Bridge and rail locks must secure and lock the bridge and movable bridge rails when they are in proper position, as follows:

(a) Bridge lock or bridge lock mechanism on movable bridge must be so checked that the bridge locking mechanism cannot be locked unless the movable members are within 1 inch of full locked position.

(b) Rail lock mechanism on movable bridge must be so checked that it cannot be locked with the rail displaced $\frac{3}{8}$ inch or more from its proper position.

3. Power or power equipment for bridge operation and for operation of devices which check the surface and alignment of rails, check bridge locking mechanism or operate bridge circuit controller must be so maintained that the signals and the movement of each device follow in predetermined order.

4. Each bridge and locking device must be tested as instructed to determine that no locking device will complete its locking function when the permissible tolerances in alignment or position of the members to be locked by the device are exceeded.

5. At the time tests are being made, careful examination of the locks and parts effective in the locking must be made to determine that they are properly lubricated and in good working order. When defective or improper operation or condition in bridge or rail locking is found, measures must be taken to protect train movements and proper authority notified.

6. The operation of the circuit controller for signal circuits must be so maintained that its contacts will not close unless the bridge and rails are in proper position for train operation.

* The term "as instructed" as used herein refers to individual railroad instructions.

7. Signal protection for movable bridges must be maintained and tested in accordance with these instructions and also, in so far as they apply:

(a) Instructions for Automatic Block Signal Systems, Manual Part 102.

(b) Instructions for Interlockings, Manual Part 138.

8. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Signal Protection for Movable Bridges, Manual Part 233.

COOPERATIVE REPORT

PURCHASES AND STORES DIVISION, A.A.R.
GENERAL RECLAMATION COMMITTEE**E. B. Platt, Representative*

The General Reclamation Committee have had two meetings which were attended by Mr. E. B. Platt, Signal Section Representative.

The efforts of the Committee during the year were directed more towards diversified reclamation than to an extensive detailed report on any one particular subject, and for that reason rather a large number of items were covered.

The report for inclusion in the Advance Notice for the 1951 Annual Meeting of the Purchases and Stores Division, A.A.R., has set up a list of practices on certain railroads under the heading "Helpful Hints." They are not recommended as standard practices, but to show what other railroads are able to do with material that in most cases has outlived its usefulness as originally intended. The items covered are:

- AB valve reservoirs
- Freight car oil and packing
- Frog and switch point reclamation
- Insulated switch rods
- Reforming of angle bars.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
GRAPHICAL SYMBOLS AND ABBREVIATIONS—PROJECT Z32**G. A. Washburn, Representative of Engineering Division, A.A.R.*

Graphical symbols were prepared for railroad use, except those for electrical and circuit symbols, using A.A.R. and A.R.E.A. symbols in so far as possible. After much criticism and discussion, a new draft was made July 31, 1950. This draft was withdrawn on August 10, 1950 after receipt of three negative votes. A compromise solution resulted and was later submitted in a letter ballot November 28, 1950, on which your representative voted for approval with recommendation that it be submitted to A.S.A. as an American Standard.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1948 Proceedings, Vol. XLVI, pp. 272 and 540.

COMMITTEE VI—DESIGNS

Personnel

W. G. Brown, Chairman

T. W. Tizzard, Vice-Chairman

R. I. Becksted

H. P. Schmidt

E. F. Brown

P. E. Snead

W. A. Ford

C. J. R. Taylor

A. S. Haigh

D. B. Thomas

B. C. Hallowell

C. C. Thorn

W. T. Lewis

C. H. Tobin

J. C. Lummis

C. N. Tymeson

A. J. Yarrell

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Designs.
4. Specifications and drawings covering reflector lenses and similar devices for signals and signs, collaborating with Committee VIII.
5. Simplification of sizes and kinds of electric lamps for signal purposes, cooperating with Purchases and Stores Division, A.A.R.
6. Specification for concrete, reinforcement and test requirements for precast concrete foundations, monolithic and sectional types.
7. Design a universal switch adjustment bracket.
8. Design a universal adjustment bracket for application of lock rod to front rod.
9. Investigate and report on means and methods for the improvement of incandescent electric lamps used in signaling, collaborating with Committee I.
10. Investigate and report on performance and tentative design requirements as a possibility for future consideration of reflecting material as an alternate for reflector units on existing drawings which use reflector units on highway crossing signs used on railroad highway crossing signal assemblies. This to include consideration of reflecting backgrounds in lieu of reflecting legend.

The Committee submits for consideration, reports on the following subjects*:

1. Revised drawings.
Revision of Specification 155-46, Manual Part 44.
Revision of Specification 231-47, Manual Part 237.
3. New drawings.
4. Specification 255-51.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

Cooperative report. American Standards Association—Standardization and Unification of Screw Threads—Project B1.

Cooperative report. American Standards Association—Plain and Lock Washers—Project B27.

Cooperative report. American Standards Association—Sectional Committee on the Standardization of Wire and Sheet Metal Gages—Project B32.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

S.A.E.—Society of Automotive Engineers, 29 W. 39th St., New York 18, N. Y.

Disposition of 1950 Letter Ballot Subjects

The following subjects presented by Committee VI at the 1950 Annual Meeting were submitted to letter ballot and officially approved:

Specifications for Bolts, Nuts and Threads—Now in Manual Part 17.

A.A.R. Sig. Sec. 1642E—Railroad Crossing Sign—90 Degree Reflector Type for 4 to 8-Inch Pipe—Assembly—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1643E—Front Plates for Railroad Crossing Sign—90 Degree Reflector Type—Details—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1646D—Stop on Red Signal Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1648D—Stop When Swinging Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1692C—Railroad Crossing Sign—50 Degree Reflector Type for 4 to 8-Inch Pipe—Assembly—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1693D—Front Plates for Railroad Crossing Sign—50 Degree Reflector Type—Details—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1489D—Highway Crossing Signal—Flashing Light Type with Suspended Lights and Mast Mounted Gate—Assembly—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1462A—Highway Crossing Signal—Flashing Light Type with Extended Lights and Pedestal Mounted Gate—Assembly—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1463A—Cross-Arm for Extended Lights—For Flashing Light Highway Crossing Signal with Pedestal Mounted Gate—Assembly—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1464A—Cross-Arm and Brackets for Extended Lights—For Flashing Light Highway Crossing Signal—Details—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1465A—Extension Bracket—For Highway Crossing Signs—Now in Drawing Section of Manual.

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- A.A.R. Sig. Sec. 1493A—Highway Crossing Gate Roadway Arm—For Pedestal Mounting—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1494A—Highway Crossing Gate Sidewalk Arm—For Pedestal Mounting—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1488A—"No Right Turn" or "No Left Turn" Signal—Assembly—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1701A—Back Plates for Railroad Crossing Sign—90 Degree Reflector Type—Details—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1702A—Front and Back Plates for Stop on Red Signal Sign—Reflector Type—Details—Now in Drawing Section of Manual.
- A.A.R. Sig. 1703A—Front and Back Plates for Stop When Swinging Sign—Reflector Type—Details—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1704A—Back Plates for Railroad Crossing Sign—50 Degree Reflector Type—Details—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1468A—Cross-Arm for Suspended Lights—For Flashing Light Highway Crossing Signal with Mast Mounted Gate—Assembly—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1469A—Brackets for Suspended Lights—For Flashing Light Highway Crossing Signal—Details—Now in Drawing Section of Manual.
- Specification 190-50—Electric Light Unit for Highway Crossing Signal—Reflector Type—Now in Manual Part 166.
- Specification 232-50—Electric Light Unit for Highway Crossing Signal—Doublet Lens Type—Now in Manual Part 244.

(Revision of A.A.R. Signal Section Specification 155-46)
A.A.R. SIGNAL SECTION SPECIFICATION 155-51.

RAILROAD HIGHWAY GRADE CROSSING SIGNS

1. *Purpose.*

(a) This specification is for the purpose of providing signs of various designs for railroad highway grade crossing protection. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Specifications and drawings.*

(a) Specifications and drawings referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Specific detail part references as shown on drawings for:

(a) Cast-iron type.

(b) Reflector unit type.

(c) Reflex-reflecting sheet type.

1. Front plate (interchangeable with reflector unit front plate).

2. Flat single plate.

(d) Vitreous enamel finish for front plate.

(e) Synthetic enamel finish for front plate.

(f) Numeral for number of tracks.

2. Drawing reference details as required for 90 deg. railroad crossing signs:

(a) Cast-iron type—details and assembly—Drawing 1640.

(b) Reflector type—assembly—Drawing 1642.

(c) Reflector unit type front plates—details—Drawing 1643.

(d) Reflex-reflecting sheet type, front plates—details—Drawing 1706.

(e) Back plates—details—Drawing 1701.

4. *Purchaser's order requirements.*—Continued.

(f) Reflex-reflecting sheet type, flat plates—assembly—Drawing 1717.

(g) Reflex-reflecting sheet type, single flat plates—details—Drawing 1718.

3. Drawing reference details as required for 50 deg. railroad crossing signs:

(a) Reflector type—assembly—Drawing 1692.

(b) Reflector unit type front plates—details—Drawing 1693.

(c) Reflex-reflecting sheet type, front plates—details—Drawing 1705.

(d) Back plates—details—Drawing 1704.

(e) Reflex-reflecting sheet type, flat plates—assembly—Drawing 1715.

(f) Reflex-reflecting sheet type, single flat plates—details—Drawing 1716.

4. Drawing reference details as required for Number of Tracks signs:

(a) Cast-iron type—details and assembly—Drawing 1644.

(b) Reflector type—assembly—Drawing 1645.

(c) Reflector unit type front and back plates—details—Drawing 1700.

(d) Reflex-reflecting sheet type, front plates—details—Drawing 1707.

(e) Reflex-reflecting sheet type, single flat plate—detail and assembly—Drawing 1719.

(f) Numerals—details—Drawing 1650.

5. Drawing reference details as required for Stop on Red Signal signs:

(a) Reflector type—assembly—Drawing 1646.

(b) Reflector unit type front and back plates—details—Drawing 1702.

(c) Reflex-reflecting sheet type, front plate—details—Drawing 1708.

(d) Reflex-reflecting sheet type, single flat plate—details and assembly—Drawing 1720.

6. Drawing reference details as required for Stop When Swinging signs:

(a) Reflector type—assembly—Drawing 1648.

(b) Reflector unit type front and back plates—details—Drawing 1703.

(c) Reflex-reflecting sheet type, front plate—details—Drawing 1709.

(d) Reflex-reflecting sheet type, single flat plate—details and assembly—Drawing 1721.

4. *Purchaser's order requirements.*—Continued.

7. Drawing reference details as required for adapter clamps and bolts:

(a) Double adapter clamp and details for railroad crossing signs—Drawing 1641.

(b) Single adapter clamp and details for crossing signs—Drawing 1647.

8. Inspection and tests as required.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

(b) Unless specified otherwise on drawings, castings and sheet metal shall be as follows:

1. Gray iron castings shall be in accordance with A.S.T.M. current Specification A 48—Class 20.

2. Sheet metal for parts having synthetic enamel finish shall be No. 16 U.S. Standard Gage (0.0625 in.) and in accordance with the following:

(a) The total amount of carbon, manganese, phosphorous, sulphur and silicon shall not exceed 0.70 per cent. If the total of these five elements equals or exceeds 0.20 per cent, the metal shall contain not less than 0.17 per cent copper and not more than 0.06 per cent sulphur. If the total of these five elements is less than 0.20 per cent and sulphur is not greater than 0.04 per cent, the presence of copper is optional.

(b) The base metal shall be uniformly coated on both sides of the sheet with a good quality of zinc applied either by the hot dip or the electro-plating process. The zinc coating shall have a uniform dull matte surface for good adhesion of primer and shall meet the bending requirements of section 5-b-2-c. The surface of the finished sheets shall be free of any material that will be injurious to the primer, enamel or zinc coating. The weight of the zinc coating on the finished sheets shall be such as to meet a minimum requirement of 0.75 oz. per sq. ft. of sheet, as determined by the Diagonal Triple Spot Test specified in A.S.T.M. current Specification A 90.

(c) The material in the sheets shall be of such nature that the zinc coating shall adhere tightly to all parts of the sheet so that it will not peel or flake off from the outside surface of the bend when the sheet is bent around a 90 deg. angle with the sharp corner rounded to $\frac{1}{16}$ in. radius.

3. Sheet iron for parts having vitreous enamel finish shall be No. 16 U.S. Standard Gage (0.0625 in.) and of the grade known to the trade as "enameling stock." It shall be manufactured by some company recognized as producing a satisfactory material of this type and shall be of such quality

5. *Material and workmanship.*—Continued.

that will provide a high grade finished product. The following is a typical analysis of a satisfactory product:

Carbon.....	0.012 to 0.030 max.
Manganese.....	0.018 to 0.110 max.
Phosphorous.....	0.004 to 0.010 max.
Silicon.....	0.003 to 0.010 max.
Sulphur.....	0.023 to 0.045 max.

(c) Reflector units, where used, shall be in accordance with Specification 156, Manual Part 43, of proper diameter to fit $\frac{33}{64}$ in. holes for 4 in. letters and $\frac{45}{64}$ in. holes for $5\frac{1}{2}$ in. letters and numerals.

(d) Reflex-reflecting sheet material, where used, shall be in accordance with Specification 255, Manual Part

6. *Reflector unit assembly.*

(a) Reflector units shall be held in a fixed relation to the aperture with their axes normal to the face of the sign.

(b) Reflector units shall be readily removable for replacement when the front plate is taken off. When mounted from the rear, they shall be held in position to facilitate assembly.

(c) Reflector units shall project not more than $\frac{1}{4}$ in. outside of aperture.

7. *Front plates and back plates (box type).*

(a) The front plate shall be attached to the back plate by bronze or stainless steel screws and nuts of theft-resisting type which cannot be removed with ordinary pliers, wrench, or screw driver.

8. *Welding.*

(a) Support straps, where called for on box type plates or on flat plates shall be securely welded to the sheet metal by methods which will provide a firm bond without warpage. If spot welding is used it shall be applied at intervals no greater than $4\frac{1}{2}$ in., starting $\frac{5}{8}$ in. from each end. Prior to welding, the surface of the sheet metal and the strap shall be treated with a suitable primer paint and the welding done while primer is wet.

9. *Painting.*

(a) All metal surfaces shall be thoroughly cleaned in order to secure a suitable surface for painting.

(b) Cast-iron signs shall be treated as follows:

1. One coat of primer in accordance with Specification 201, Type III, Manual Part 65, or equivalent, applied to all surfaces.

2. Two finish coats of white in accordance with Specification 227, Manual Part 235, applied to all surfaces.

3. Two finish coats of black in accordance with Specification 227, Manual Part 235, applied to letters and numerals, over the white coats.

9. *Painting.*—Continued.

(c) Sheet metal signs of reflector unit type, having synthetic enamel finish, shall be treated as follows:

1. One coat of primer in accordance with Specification 201, Type III, Manual Part 65, or equivalent, applied to all surfaces.

2. Three finish coats of white in accordance with Specification 227, Manual Part 235, shall be applied as called for on drawings:

(a) All surfaces of railroad crossing signs.

(b) Back surface on all back plates.

(c) Letters and numerals on other than railroad crossing signs.

3. Two coats of black in accordance with Specification 227, Manual Part 235, shall be applied as called for on drawings:

(a) Letters on railroad crossing signs (over the white coats).

(b) All surfaces on front plates other than railroad crossing and on inside surfaces on all back plates (prior to white coats for letters and numerals).

4. One coat of non-reflecting black in accordance with Specification 214, Manual Part 221, on front surface of front plates, other than railroad crossing, prior to white coats for letters and numerals.

5. All letters and numerals shall be true as to edge and form, and holes for reflector units shall be evenly spaced with reference to the edges.

10. *Vitreous enamel finish.*

(a) Prior to the application of the porcelain enamel coatings, the metal shall be thoroughly cleaned to free it of all foreign substances such as dirt, scale, and grease, by immersion in an acid bath followed by proper washing and neutralization.

(b) After the piece has been properly pickled, a grip or ground coat shall be applied by spraying. This coat shall be applied to all parts of the piece—front, back, sides, and edges. When fused, the ground coat shall present a lustrous, continuous surface of porcelain enamel over all parts of the sign, of uniform thickness and free from blisters, copperheads, or other defects which would permit of access or contact of the atmosphere with the steel.

(c) Where white is called for on drawings it shall consist of two coats separately applied and fused. The final coat shall have architectural finish.

(d) Where black is called for it shall consist of two coats separately applied and fused. The final coat shall have architectural finish.

(e) The enamel application shall be as thin as practicable to insure a strong, tenacious covering which will be resistant against abrasion and chipping.

10. *Vitreous enamel finish.*—Continued.

(f) Great care shall be exercised to prevent the formation of heavy enamel in the openings in the plate. All holes for reflector units shall be carefully wiped for a distance of $\frac{1}{8}$ in. around the edge of the hole in order to provide a uniform diameter and to prevent the accumulation of enamel around the hole edges.

(g) All letters and numerals shall be true as to edge and form, and holes for reflector units shall be evenly spaced with reference to the edges.

(h) Plates shall be free from objectionable warpage.

11. *Reflex-reflecting sheet finish.*

(a) Railroad crossing signs.

1. Reflecting material shall be for background only as called for on drawings.

2. Prior to application of reflex-reflecting sheet, the signs shall have complete paint treatment as follows:

(a) For box type front plates requiring synthetic enamel finish treat per sections 9-c-1 and 9-c-2-a.

(b) For box type front plates requiring vitreous enamel finish treat per sections 10-a, b, c, e, f and h.

(c) For box type back plates and for single plate type signs (synthetic enamel finish only) treat all surfaces with one coat of primer per section 9-c-1 and three coats of white per section 9-c-2.

3. The reflex-reflecting sheet shall be in accordance with Specification 255, Manual Part, and shall be cut with square corners for application to the entire front surface of the front plate except for a space of approximately, but not less than, $\frac{1}{16}$ in. from the edges.

4. The adhesive backing shall be activated by the prescribed solvent or by heat, and the sheeting then applied by hand roller, squeeze roller or vacuum applicator to form a durable bond to the enamel finish and not closer than $\frac{1}{16}$ in. to any edge of plate.

5. Lettering conforming to drawing shall then be applied over the reflex sheeting, by use of pre-cut synthetic lettering film having adhesive backing, or by use of heavy black paste enamel applied with a silk screen process.

(b) Signs other than railroad crossing.

1. Reflecting material shall be for letters and numerals only, as called for on drawings.

2. Prior to application of reflex-reflecting letters or numerals, the signs shall have complete paint treatment as follows:

(a) For box type front plates requiring synthetic enamel finish treat per sections 9-c-1, 9-c-3-b and 9-c-4.

(b) For box type front plates requiring vitreous enamel finish treat per sections 10-a, b, d, e, f and h.

11. *Reflex-reflecting sheet finish.*—Continued.

(c) For box type back plates (synthetic enamel finish only) treat per sections 9-c-1 and 9-c-2-b.

(d) For single plate types (synthetic enamel finish only) treat with one coat of primer per section 9-c-1, two coats black per section 9-c-3, followed by one coat per section 9-c-4 on front surface only.

3. The reflex-reflecting letters and numerals shall conform to drawing and shall be pre-cut from material in accordance with Specification 255, Manual Part

4. Application of letters and numerals shall be made in accordance with drawing, by activating the adhesive backing with the prescribed solvent or by heat, and then applying with a hand roller, squeeze roller or vacuum applicator to form a durable bond to the enamel finish.

(c) All letters and numerals shall be true as to edge and form.

12. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

13. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

14. *Packing.*

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

15. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

16. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 2 years after shipment to the Purchaser. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 155-46—Railroad¹ Highway Grade Crossing Signs,
Manual, Part 44.

(Revision of A.A.R. Signal Section Specification 231-50)
A.A.R. SIGNAL SECTION SPECIFICATION 231-51.

"NO RIGHT TURN"—"NO LEFT TURN" ILLUMINATED SIGN

Proposed Revision

6. *Design.*

- (a) Case and door shall be cast aluminum alloy in accordance with A.S.T.M. current Specification B 26, aluminum base alloy sand castings. Alloy number and treatment as required.
*R-6-a.

Alternate requisites.

R-6-a.

Case and door shall be:

1. Die cast alloy in accordance with A.S.T.M. current Specification B 86 zinc base alloy die castings. Alloy number as required.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Section 6-a and alternate requisites section R-6-a of Specification 231-50—"No Right Turn"—"No Left Turn" Illuminated Sign, Manual Part 237.

A.A.R. SIGNAL SECTION SPECIFICATION 255-51.

REFLEX-REFLECTING SHEET MATERIAL

1. *Purpose.*

(a) This specification is for the purpose of providing a reflex-reflecting sheet material when used for signs on railroad highway crossing signal assemblies. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Specifications.*

(a) Specifications referred to in the body of this specification form an essential part hereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Purchaser's order requirements.*

(a) The following additional requirements will be shown on the Purchaser's order:

1. Inspection and tests as required.
2. Alternate requisites as required.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

6. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

7. *Design and requirements.*

(a) The product shall consist of clear glass spheres embedded in a waterproof binder and adhered to a waterproof flexible backing so as to present a smooth flat front surface and silvery appearance. The backing shall consist of synthetic sheet resin or other suitable non-cellulosic material.

(b) The product shall be supplied with a pre-coated adhesive on the back, and shall be suitable for application with a hand roller, squeeze roller, or vacuum process techniques to form a durable bond to any well-painted or vitreous enameled surface, or unpainted corrosion-resisting metal, bonderized galvanized steel, aluminum, etc.

7. *Design and requirements.*—Continued.

(c) The adhesive shall be activated by means of a solvent or heat. It shall have no staining effect and must be mildew-resistant. Any liner, which is necessary to keep the adhesive clean or from sticking, shall be removable by peeling without the necessity of soaking in water or other solvent.

(d) The product, stripped of any temporary liner and ready for application, shall have a minimum tensile strength of 3 lbs. per in. of width at 75 deg. F. It shall not be subject to shrinkage, expansion, cracking, or brittleness so as to fail under ordinary handling in shipment or application.

(e) Nighttime brightness.

1. Nighttime brightness values in dry air shall be expressed in candlepower per foot candle of incident illumination. The angles of divergence between the light source and the photometer shall be established at $\frac{1}{3}$ deg. and at 2 deg.

2. For each angle of divergence and at incident angles in steps of 10 deg., the nighttime brightness values in dry air for 1 sq. ft. of the product shall be not less than (*R-7-e-2):

Divergence angle, deg.	Incident angle					
	0°	10°	20°	30°	40°	50°
$\frac{1}{3}$	40.0	40.0	36.0	20.0	12.0	3.0
2	6.0	5.0	5.0	4.0	3.0	2.5

(f) Nighttime brightness in moderate rain (1 in. per hour) shall be not less than 80 per cent of the candlepower values shown in section 7-e-2.

(g) Daylight reflectance value in dry air shall be not less than 30 per cent of the reflectance of the completely reflecting perfectly diffusing surface defined in A.S.T.M. current Specification D 771.

(h) The product shall withstand the durability test of section 11-c without excessive loss of glass spheres. When cleaned after durability test the product shall have a nighttime brightness not less than 50 per cent of the values specified in section 7-e and shall have a daylight reflectance not less than 75 per cent of the value specified in section 7-g.

(i) The product prepared on panels as in section 11-c, shall be tested at 150 deg. F. and minus 30 deg. F. The product when so tested, shall be:

1. Adhered strongly enough to resist peeling from the panel.

2. Tough enough to resist scuffing and marring during handling and erection as normally experienced with complete signs.

3. Elastic enough to resist shocking off when struck.

4. Moisture-resistant enough to adhere well at each test temperature specified after soaking in water for 6 hours at 75 deg. F. before each test.

* Alternate requisites section.

8. *Sampling.*

(a) Three 12 in. by 12 in. samples of the product shall be selected at random from each 300 sq. ft. or fraction thereof for testing.

9. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

10. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the material or product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material or product shall be tested.

11. *Method of tests.*

(a) Nighttime brightness.

1. In dry air.

(a) This test shall be performed in accordance with the photometric test for reflex-reflectors, S.A.E. Recommended Practice.

2. In moderate rain.*

(a) Tests shall be made following the same procedure as for dry air, after the sample has been subjected to the rain for 15 minutes.

* Artificial rain of this intensity may be developed by using the nozzle furnishing 1 in. per hour together with the equipment described by Landsberg and Moody "Devices for Producing Artificial Rainfall for Tests of Water Repellant and Waterproof Materials," Textile Research Journal 16, No. 5, pp. 211-28, May 1946.

11. *Method of tests.*—Continued.

(b) Daylight reflectance.

1. Test shall be made for "Daylight 45 deg., zero deg. Luminous Directional Reflectance of Paint Finishes" in accordance with A.S.T.M. current Specification D 771.

(c) Durability.

1. Accelerated weathering tests shall be performed in the following manner: a strip of the product (approximately 2 in. by 11 in.) shall be bonded to a panel 3 in. by 12 inches in the manner prescribed by the Manufacturer and allowed to set for 48 hours at 75 deg. F. before testing. These test panels shall be placed in a vertical position, in an Atlas Twin Arc Weather-O-Meter, and tested in accordance with the recommended practice prescribed in A.S.T.M. current Specification D 822. The apparatus shall be operated in 20-minute cycles each one of which shall be divided into two periods during which the test panels shall be exposed to light without water spray for 17 minutes and to light with water spray for 3 minutes. Cycles shall be run until the total exposure is 720 hours.

(d) Physical properties.

1. Resistance to peeling, scuffing and marring when dry shall be tested with a stiff putty knife.

2. Elasticity shall be checked by dropping a 2-lb. steel ball on a rigidly supported test panel from a height of 10 ft.

3. Moisture resistance of adhesive shall be tested after water treatment by the same method as in section 11-d-1.

12. *Packing.*

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

13. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

14. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-7-e-2.

For each angle of divergence and at incident angles in steps of 10 deg., the nighttime brightness values in dry air for 1 sq. ft. of the product shall be not less than:

Divergence angle, deg.	Incident angle			
	0°	10°	20°	30°
$\frac{1}{3}$	40.0	35.0	9.0	1.0
2	7.0	6.0	5.0	1.0

Action Recommended

Acceptance for submission to letter ballot.

REVISED DRAWINGS

A.A.R. Sig. Sec. 1642F—Railroad Crossing Sign—90 Deg. Reflector Type for 4 to 8-Inch Pipe—Assembly.

Arranged together with new drawing, A.A.R. Sig. Sec. 1706A, to include sign of reflex-reflecting sheet type.

A.A.R. Sig. Sec. 1645E—Number of Tracks Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly.

Arranged together with new drawing, A.A.R. Sig. Sec. 1707A, to include sign of reflex-reflecting sheet type.

A.A.R. Sig. Sec. 1646E—Stop on Red Signal Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly.

Arranged together with new drawing, A.A.R. Sig. Sec. 1708A, to include sign of reflex-reflecting sheet type.

A.A.R. Sig. Sec. 1648E—Stop When Swinging Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly.

Arranged together with new drawing, A.A.R. Sig. Sec. 1709A, to include sign of reflex-reflecting sheet type.

A.A.R. Sig. Sec. 1692D—Railroad Crossing Sign—50 Deg. Reflector Type for 4 to 8-Inch Pipe—Assembly.

Arranged together with new drawing, A.A.R. Sig. Sec. 1705A, to include sign of reflex-reflecting sheet type.

A.A.R. Sig. Sec. 1643F—Front Plates for Railroad Crossing Sign—90 Deg. Reflector Unit Type—Details.

A.A.R. Sig. Sec. 1693E—Front Plates for Railroad Crossing Sign—50 Deg. Reflector Unit Type—Details.

A.A.R. Sig. Sec. 1702B—Front and Back Plates for Stop on Red Signal Sign—Reflector Unit Type—Details.

A.A.R. Sig. Sec. 1703B—Front and Back Plates for Stop When Swinging Sign—Reflector Unit Type—Details.

Titles changed to indicate that signs are of the reflector unit type.

A.A.R. Sig. Sec. 1700B—Front and Back Plates for Number of Tracks Sign—Reflector Unit Type—Details.

Title changed in accordance with latest practice and arranged to indicate that sign is of the reflector unit type.

A.A.R. Sig. Sec. 1462B—Highway Crossing Signal—Flashing Light Type with Extended Lights and Pedestal Mounted Gate—Assembly.

A.A.R. Sig. Sec. 1489E—Highway Crossing Signal—Flashing Light Type with Suspended Lights and Mast Mounted Gate—Assembly.

A.A.R. Sig. Sec. 1691E—Highway Crossing Sign—50 Deg. Reflector Type—Assembly.

Arranged to include references to signs of reflex-reflecting sheet type.

- A.A.R. Sig. Sec. 1651F—Highway Crossing Signal—Wig-Wag Type with Stop When Swinging Sign—Assembly.
- A.A.R. Sig. Sec. 1652F—Highway Crossing Signal—Wig-Wag Type with Stop Sign—Assembly.
- A.A.R. Sig. Sec. 1653F—Highway Crossing Signal—Flashing Light Type with Stop on Red Signal Sign—Assembly.
- A.A.R. Sig. Sec. 1654F—Highway Crossing Signal—Flashing Light Type with Stop Sign—Assembly.
- A.A.R. Sig. Sec. 1686F—Highway Crossing Signal—Flashing Light Type, 6 Ft. and 8 Ft. Cantilever Span—Assembly.
- A.A.R. Sig. Sec. 1688D—Highway Crossing Signal—Flashing Light Type, 10 Ft. and 12 Ft. Cantilever Span—Assembly.
- Titles changed in accordance with latest practice and arranged to include references to signs of reflex-reflecting sheet type.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

- 1642E—Railroad Crossing Sign—90 Deg. Reflector Type for 4 to 8-Inch Pipe—Assembly.
- 1645D—Number of Tracks Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly.
- 1646D—Stop on Red Signal Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly.
- 1648D—Stop When Swinging Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly.
- 1692C—Railroad Crossing Sign—50 Deg. Reflector Type for 4 to 8-Inch Pipe—Assembly.
- 1643E—Front Plates for Railroad Crossing Sign—90 Deg. Reflector Type—Details.
- 1693D—Front Plates for Railroad Crossing Sign—50 Deg. Reflector Type—Details.
- 1702A—Front and Back Plates for Stop on Red Signal Sign—Reflector Type—Details.
- 1703A—Front and Back Plates for Stop When Swinging Sign—Reflector Type—Details.
- 1700A—Number of Tracks Sign—Reflector Type—Details.
- 1462A—Highway Crossing Signal—Flashing Light Type with Extended Lights and Pedestal Mounted Gate—Assembly.
- 1489D—Highway Crossing Signal—Flashing Light Type with Suspended Lights and Mast Mounted Gate—Assembly.
- 1691D—Highway Crossing Sign—50 Deg. Reflector Type.
- 1651E—Highway Crossing Signal Assembly—Wig-Wag Type.
- 1652E—Highway Crossing Signal Assembly—Wig-Wag Type.
- 1653E—Highway Crossing Signal Assembly—Flashing Light Type.
- 1654E—Highway Crossing Signal Assembly—Flashing Light Type.
- 1686E—Highway Crossing Flashing Light Signal Assembly—6 Ft. and 8 Ft. Cantilever Span.
- 1688C—Highway Crossing Flashing Light Signal Assembly—10 Ft. and 12 Ft. Cantilever Span.

NEW DRAWINGS

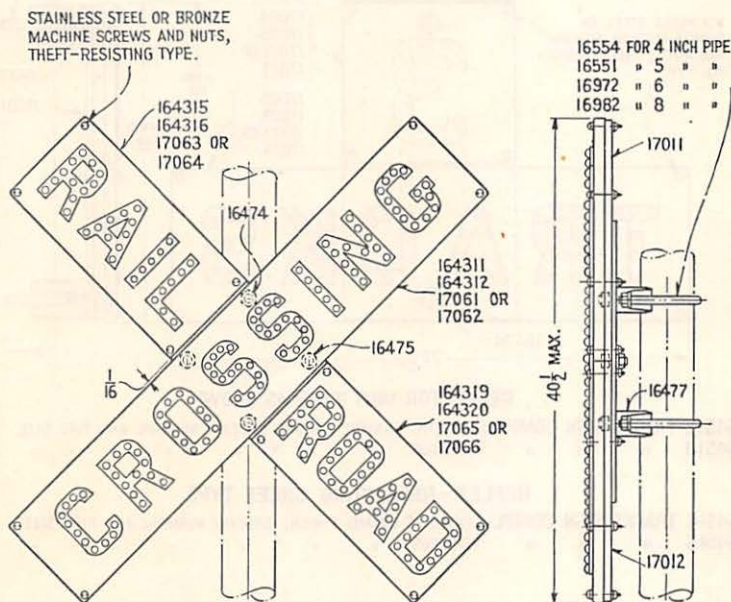
- A.A.R. Sig. Sec. 1705A—Front Plates for 50 Deg. Railroad Crossing Sign—Reflex-Reflecting Sheet Type for Back Plates 17041 and 17042—Details.
A.A.R. Sig. Sec. 1706A—Front Plates for 90 Deg. Railroad Crossing Sign—Reflex-Reflecting Sheet Type for Back Plates 17011 and 17012—Details.
A.A.R. Sig. Sec. 1707A—Front Plates for Number of Tracks Sign—Reflex-Reflecting Sheet Type for Back Plate 17001—Details.
A.A.R. Sig. Sec. 1708A—Front Plate for Stop on Red Signal Sign—Reflex-Reflecting Sheet Type for Back Plate 17021—Detail.
A.A.R. Sig. Sec. 1709A—Front Plate for Stop When Swinging Sign—Reflex-Reflecting Sheet Type for Back Plate 17031—Detail.
See explanation under revised drawings A.A.R. Sig. Sec. 1642F, 1645E, 1646E, 1648E and 1692D.

- A.A.R. Sig. Sec. 1715A—50 Deg. Railroad Crossing Sign—Reflex-Reflecting Sheet Type for 4 to 8-Inch Pipe—Assembly.
A.A.R. Sig. Sec. 1716A—Plates for 50 Deg. Railroad Crossing Sign—Reflex-Reflecting Sheet Type—Details.
A.A.R. Sig. Sec. 1717A—90 Deg. Railroad Crossing Sign—Reflex-Reflecting Sheet Type for 4 to 8-Inch Pipe—Assembly.
A.A.R. Sig. Sec. 1718A—Plates for 90 Deg. Railroad Crossing Sign—Reflex-Reflecting Sheet Type—Details.
A.A.R. Sig. Sec. 1719A—Number of Tracks Sign—Reflex-Reflecting Sheet Type for 4 to 8-Inch Pipe—Detail and Assembly.
A.A.R. Sig. Sec. 1720A—Stop on Red Signal Sign—Reflex-Reflecting Sheet Type for 4 to 8-Inch Pipe—Detail and Assembly.
A.A.R. Sig. Sec. 1721A—Stop When Swinging Sign—Reflex-Reflecting Sheet Type for 4 to 8-Inch Pipe—Detail and Assembly.

Drawings prepared in connection with Signal Section specifications being revised to include reflex-reflecting sheet type signs.

Action Recommended

Acceptance for submission to letter ballot.



REFLECTOR UNIT TYPE AS SHOWN

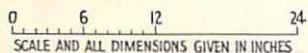
16428 RAILROAD CROSSING SIGN COMPLETE, SYNTHETIC ENAMEL FINISH, SPECIFY PIPE SIZE.

16429 " " " " VITREOUS " " * " " "

REFLEX-REFLECTING SHEET TYPE

164210 RAILROAD CROSSING SIGN COMPLETE, SYNTHETIC ENAMEL FINISH, SPECIFY PIPE SIZE.

164211 " " " " VITREOUS " " * " " "



* ON FRONT PLATES ONLY.

RAILROAD CROSSING SIGN

90° REFLECTOR TYPE FOR 4 TO 8 INCH PIPE — ASSEMBLY

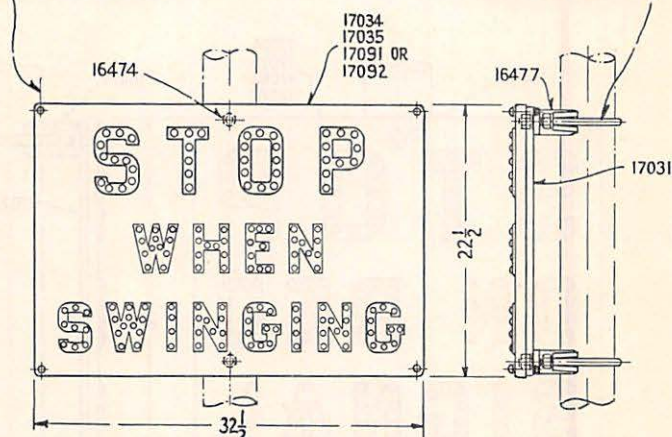
AAR
SIG. SEC.

SEP 1951 | M-1950 | SEP 1950 | M-1947 | SEP 1947 | M-1942 | OCT 1942 | M-1937 | MAR 1937 | M-1933 | MAY 1933

1642F

STAINLESS STEEL OR BRONZE
MACHINE SCREWS AND NUTS
THEFT-RESISTING TYPE

16554 FOR 4 INCH PIPE
16551 " 5 " "
16972 " 6 " "
16982 " 8 " "



REFLECTOR UNIT TYPE AS SHOWN

16487 STOP WHEN SWINGING SIGN COMPLETE, SYNTHETIC ENAMEL FINISH, SPECIFY PIPE SIZE.

16488 " " " " " VITREOUS " " * " " "

REFLEX-REFLECTING SHEET TYPE

16489 STOP WHEN SWINGING SIGN COMPLETE, SYNTHETIC ENAMEL FINISH, SPECIFY PIPE SIZE.

164810 " " " " " VITREOUS " " * " " "

* ON FRONT PLATE ONLY

0 6 12 24
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

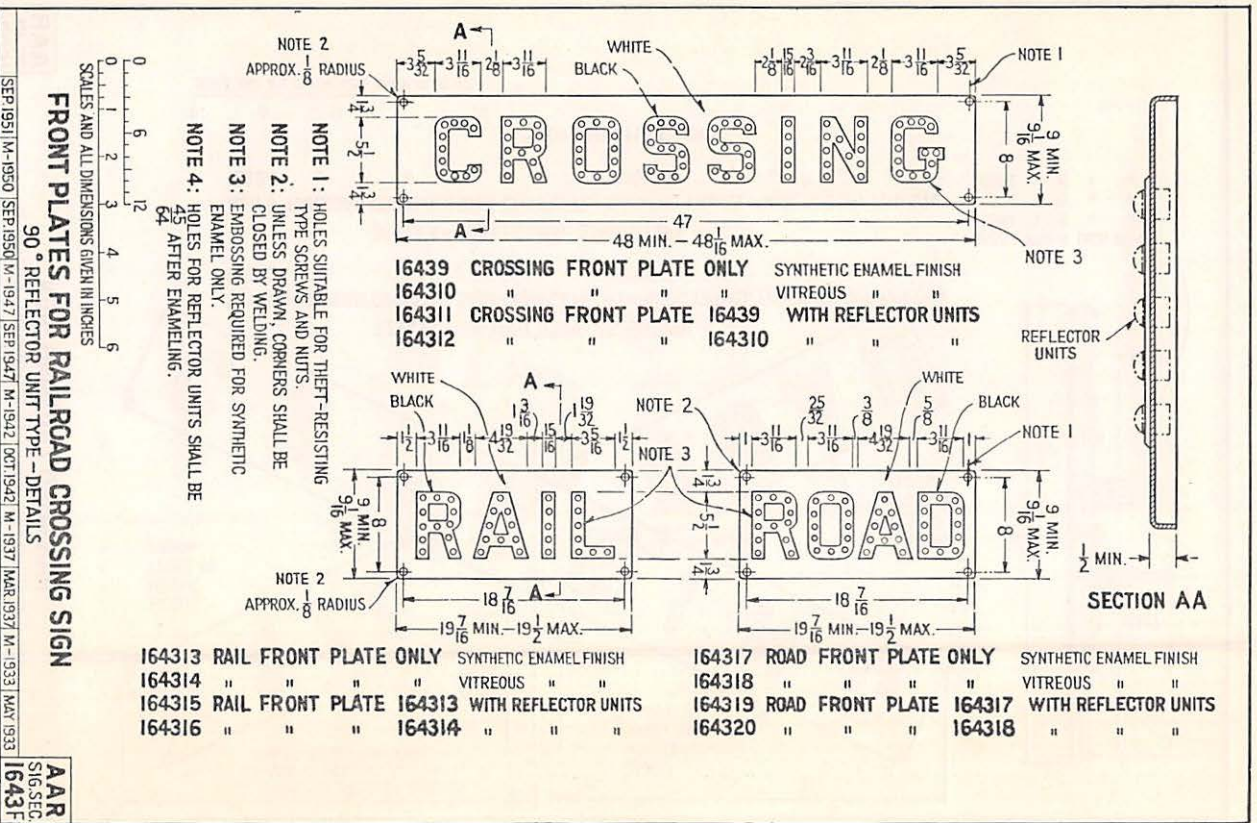
STOP WHEN SWINGING SIGN

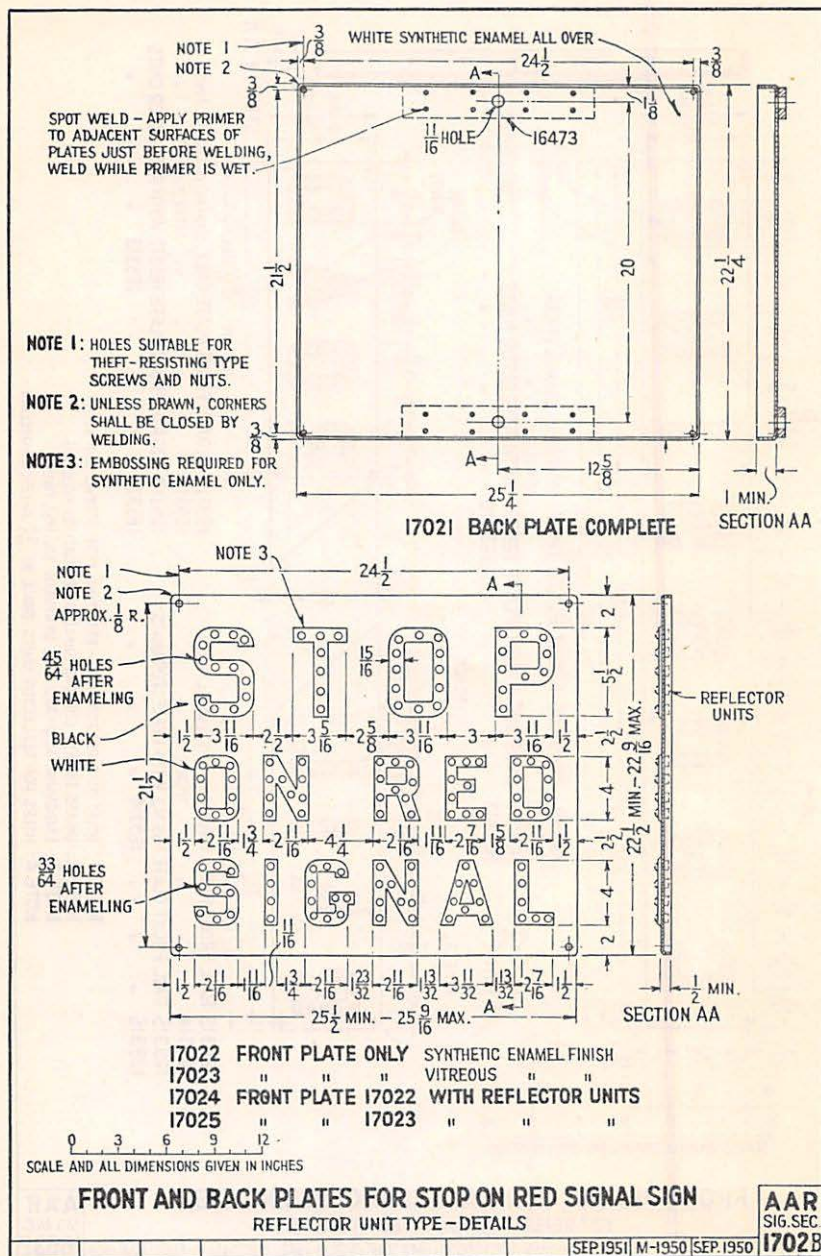
REFLECTOR TYPE FOR 4 TO 8 INCH PIPE - ASSEMBLY

AAR
SIG SEC.

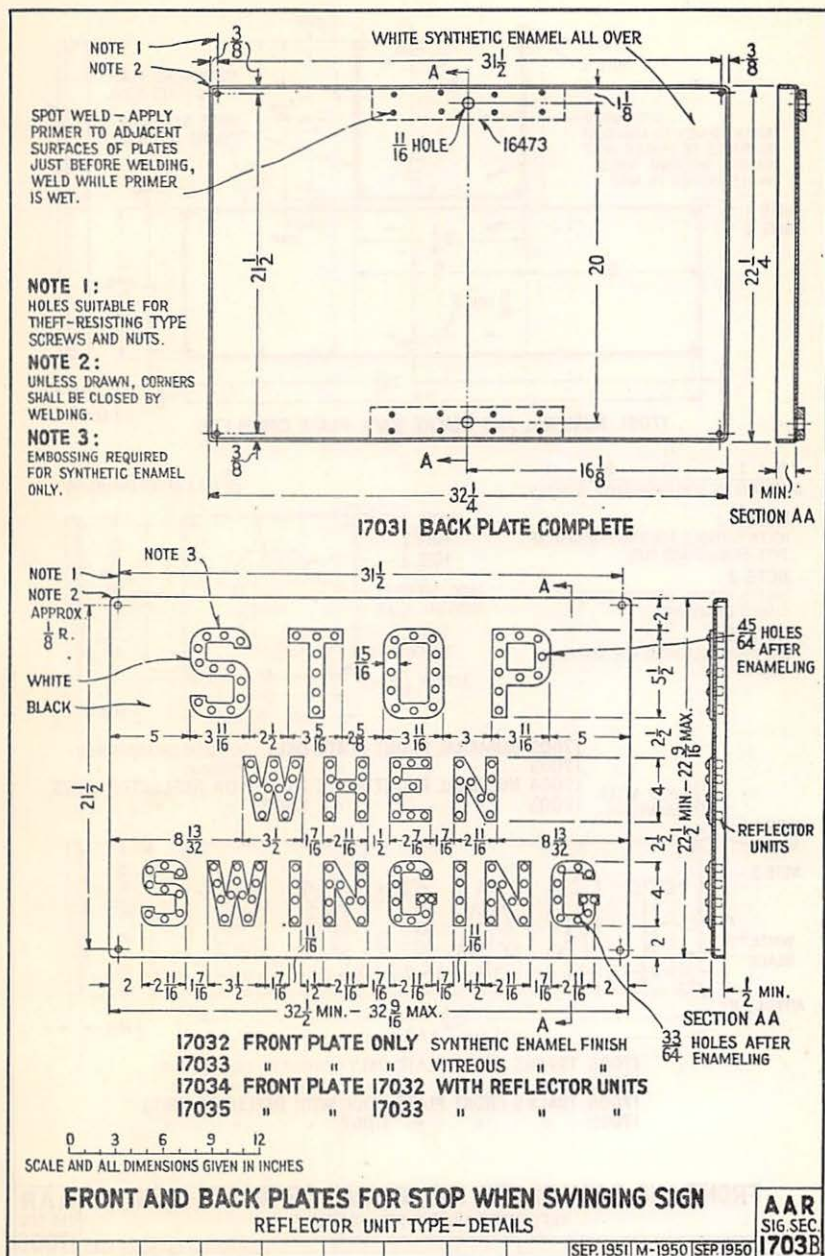
SEP. 1951 | M-1950 | SEP. 1950 | M-1947 | SEP. 1947 | M-1937 | MAR. 1937 | M-1933 | MAY 1933

1648E





Material and painting shall be in accordance with Specifications 155 and 156,
Manual Parts 44 and 43.



Material and painting shall be in accordance with Specifications 155 and 156,
Manual Parts 44 and 43.

HIGHWAY CROSSING SIGNAL

SEP. 1951	M-1950	SEP. 1950	M-1947	SEP. 1947	M-1945	OCT. 1945	M-1943	OCT. 1943
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AAR
SIG. SEC.
1489E

NOTE 1 : ELECTRIC LIGHT UNITS AAR SIG. SEC
SPEC. 236, MANUAL PART 263.

NOTE 2: 16961 WITH SIDEWALK ARM ON TRACK SIDE AS SHOWN.

NOTE 3: 16962 WITH SIDEWALK ARM ON FIELD SIDE
1/2 X 3 1/2 BOLT WITH NUT, PLAIN WASHER
AND EXTRA HEAVY SPRING LOCK WASHER.
BOLT, NUT AND PLAIN WASHER SHALL BE
GALVANIZED OR CADMIUM PLATED AFTER
THREADS HAVE BEEN CUT.

16404 MODIFIED,
16428, 16429,
164210, 164211
17171 OR 17172

16444, 164512, 164513,
164514, 164515,
17191 OR 17192 —

14681, 14682, 14683 OR 14684

ELECTRIC LIGHT UNITS AAR SIG. SEC.
SPEC. 190, MANUAL PART 166 OR
AAR SIG. SEC. SPEC. 232, MANUAL
PART 244

16467, 16468,
16469, 164610,
17201 OR 17202

ELECTRIC MOTOR MECHANISM AND
GATE ARM AAR SIG SEC. SPEC. 199,
MANUAL PART 194

SPECIFY DIMENSIONS A-B-C
AND LENGTH

3 FT. 0 MIN.
4 FT. 0 MAX.

TOP OF FOUNDATION
6 IN. ABOVE CROWN OF HIGHWAY

5 INCH PIPE -
13 FT. 0 LONG

14711 OR 14471

END OF
COUNTERWEIGHT
ARM.

MAX:-

MAX-

13

— LENGTH —

WALK ARM WHEN RE-
D. SPECIFY LENGTH

11078

NOTE 2

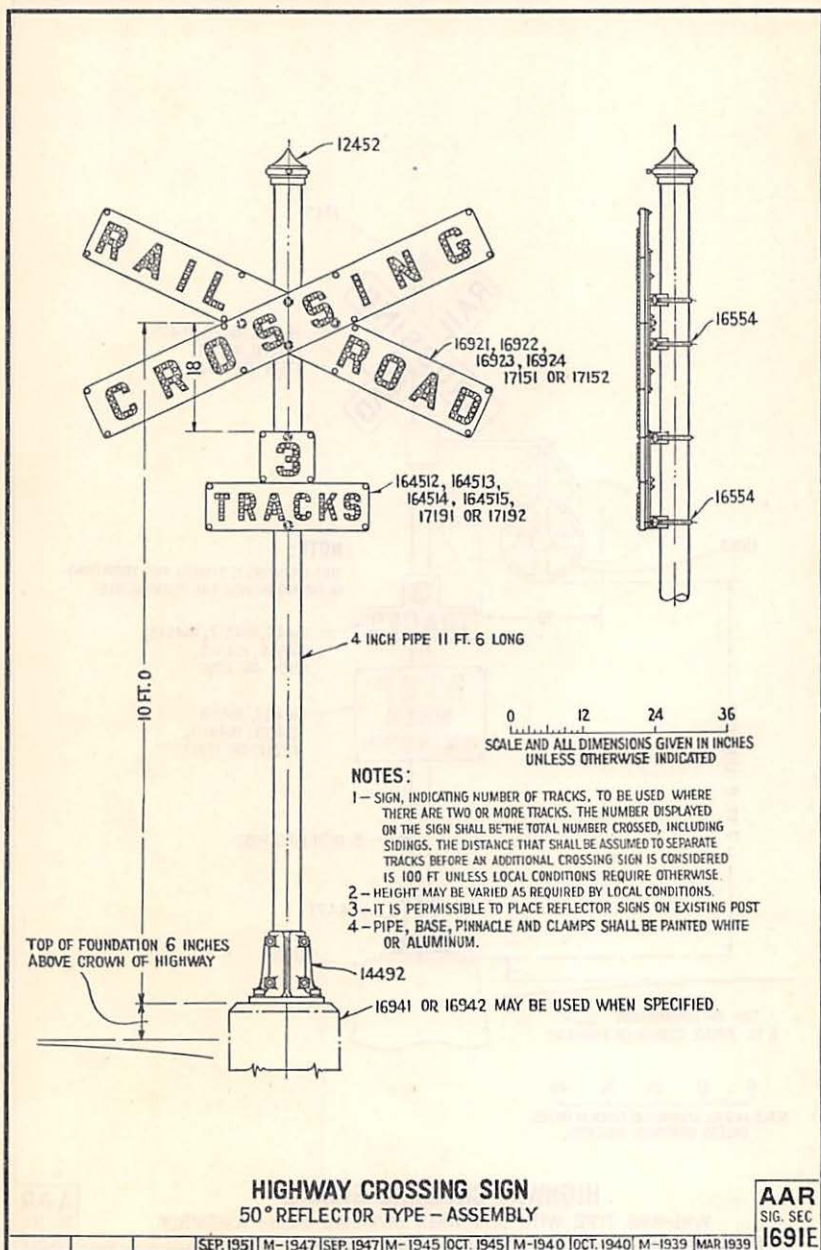
NOTE 3

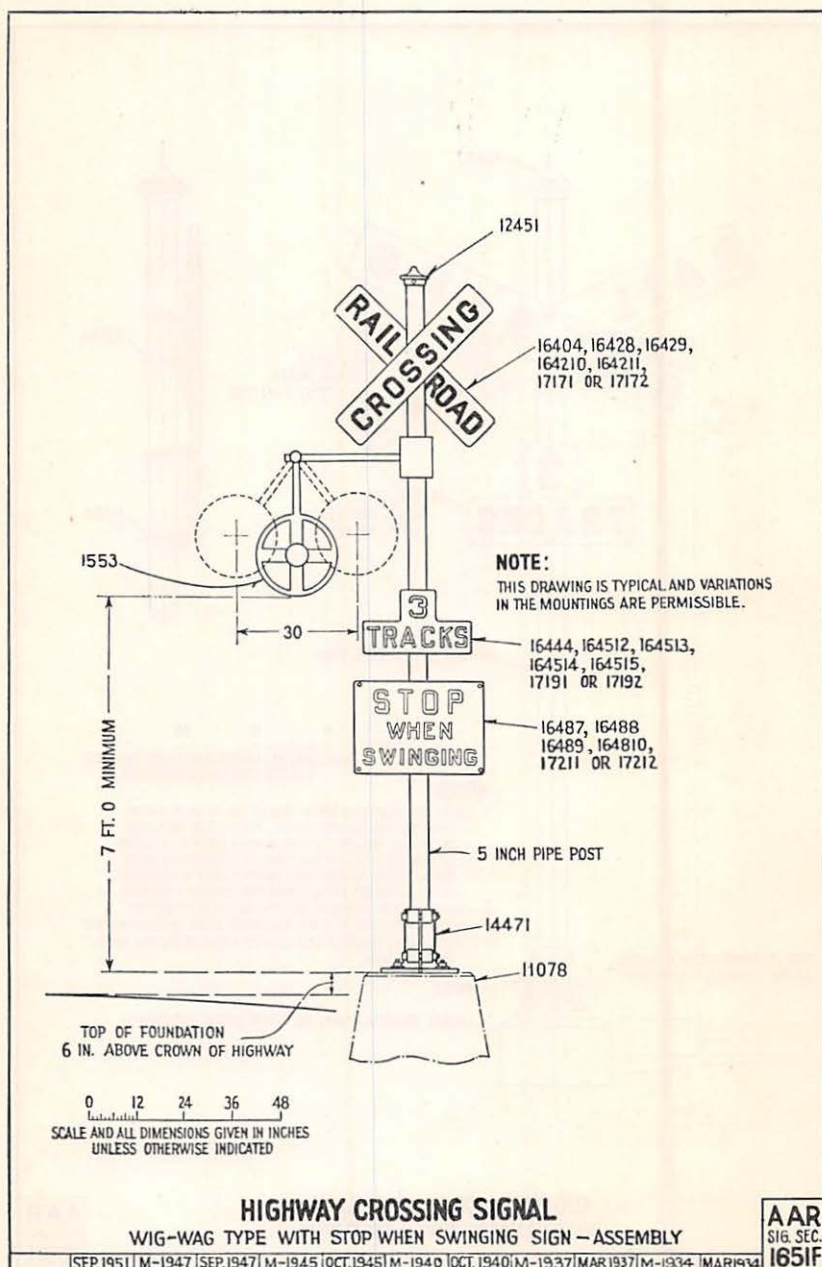
12451

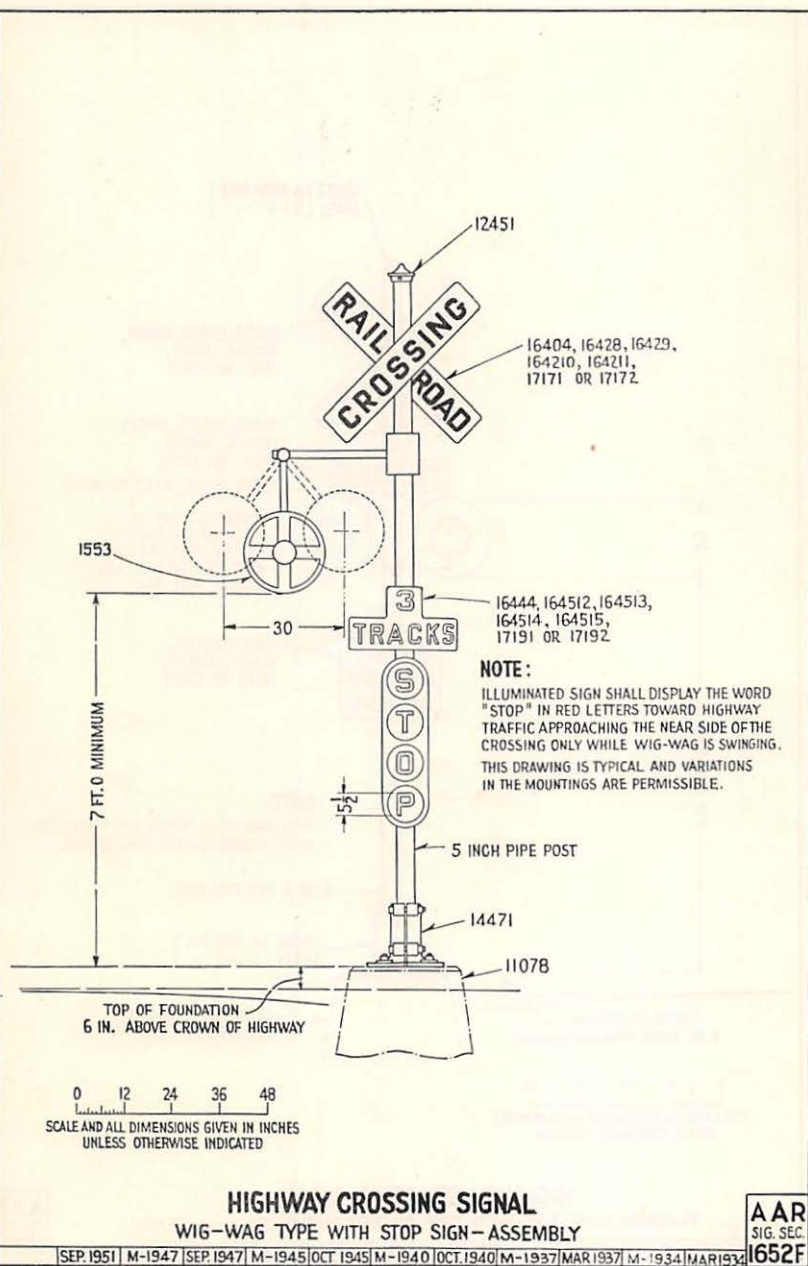
6962

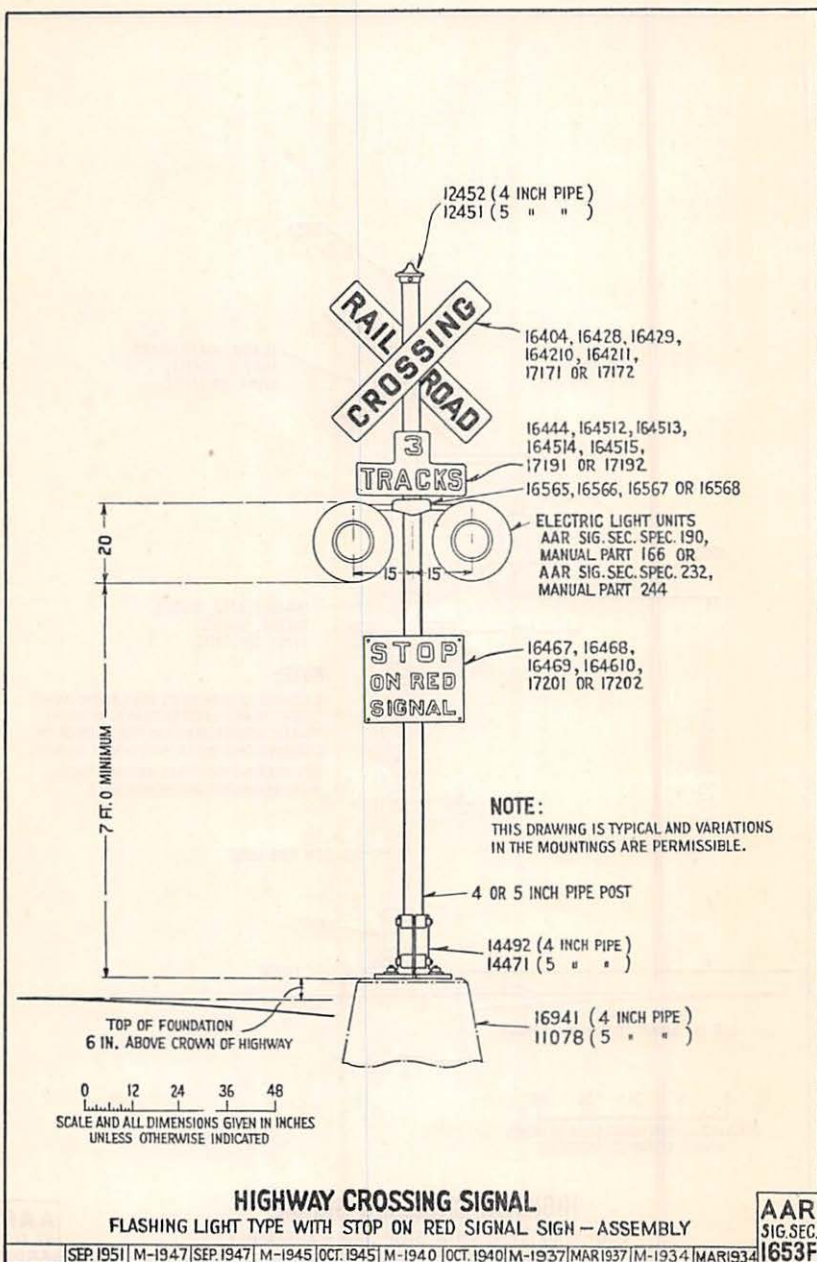
921

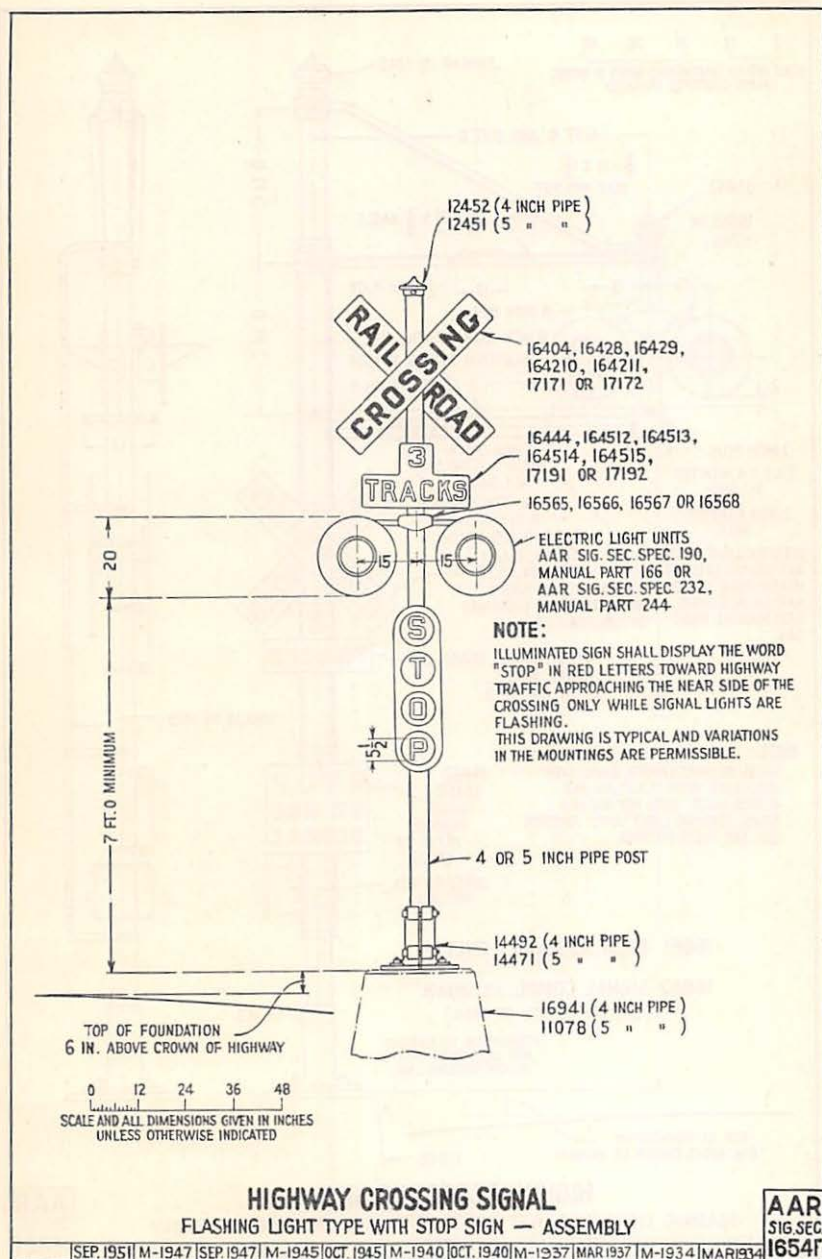
0 12 24 36 48 60 72
SCALE AND ALL DIMENSIONS GIVEN IN INCHES
UNLESS OTHERWISE INDICATED

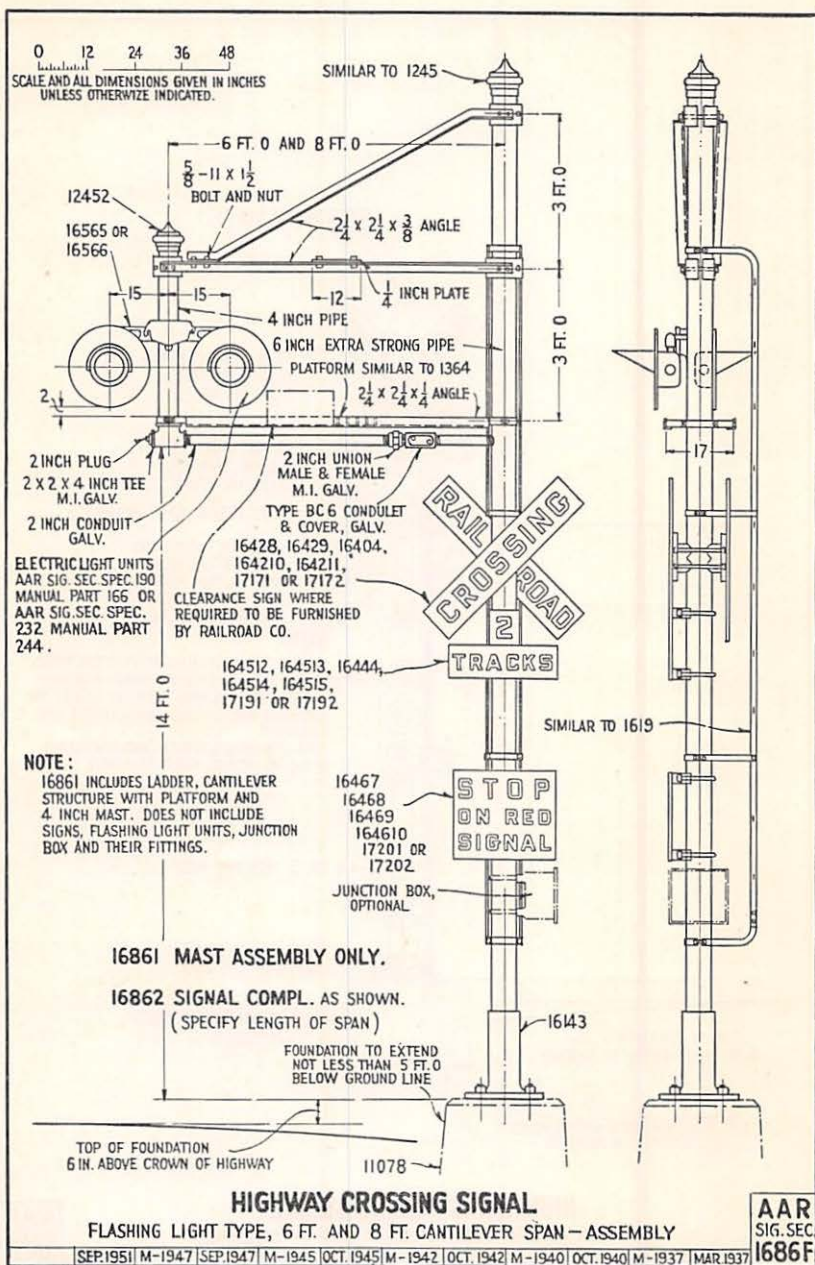




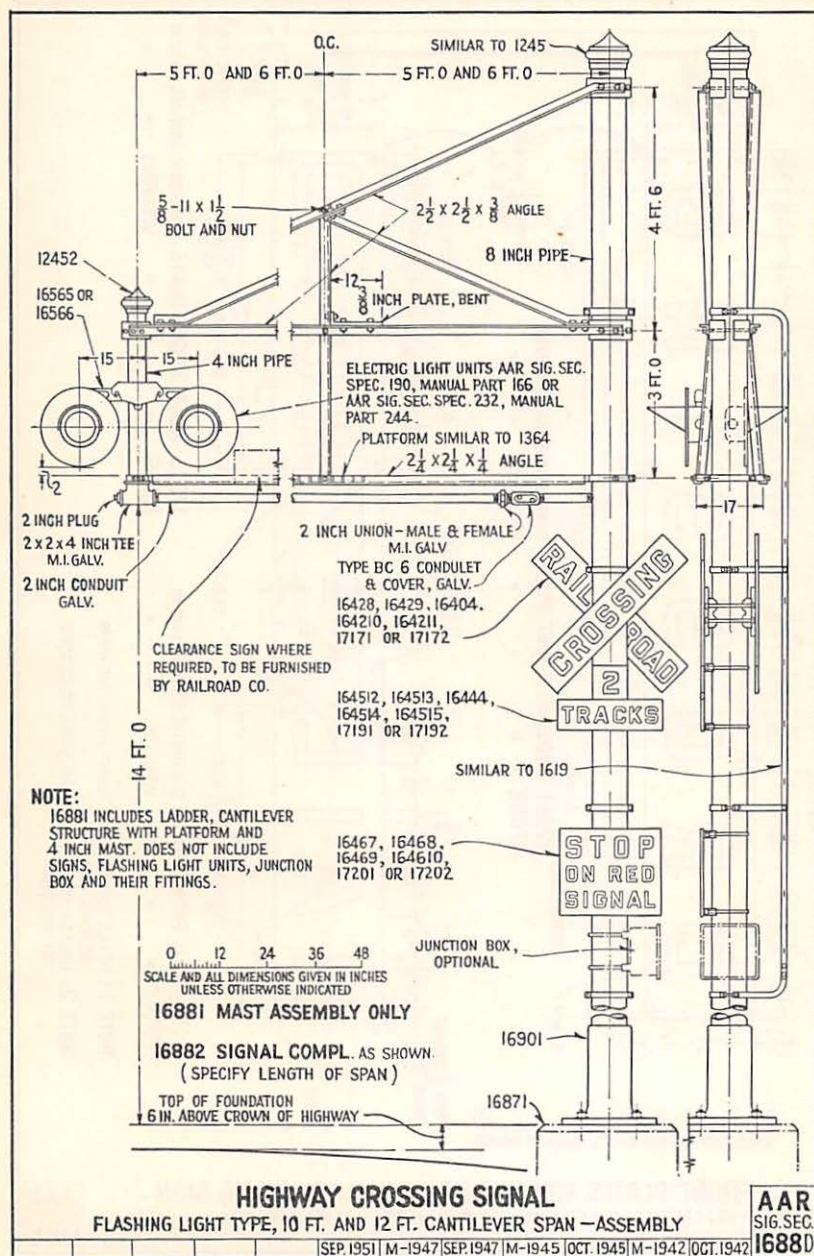


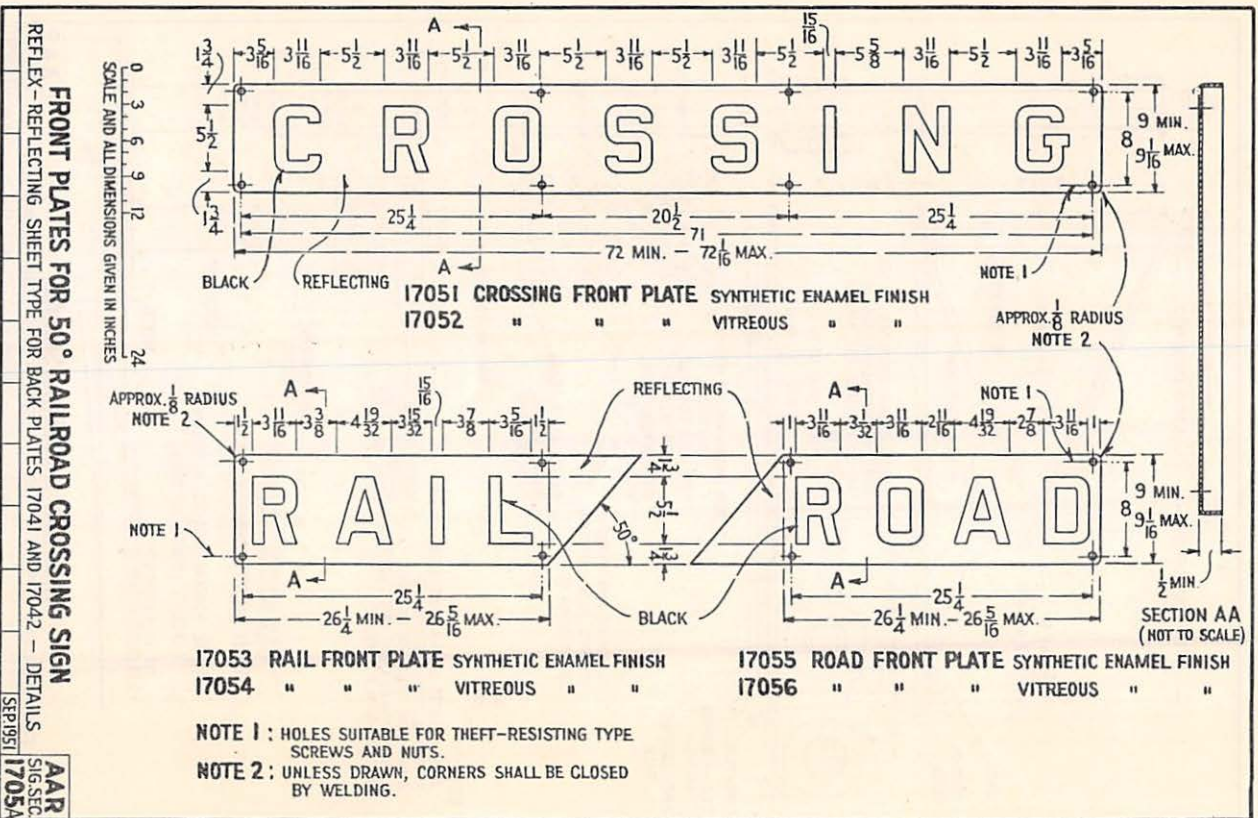






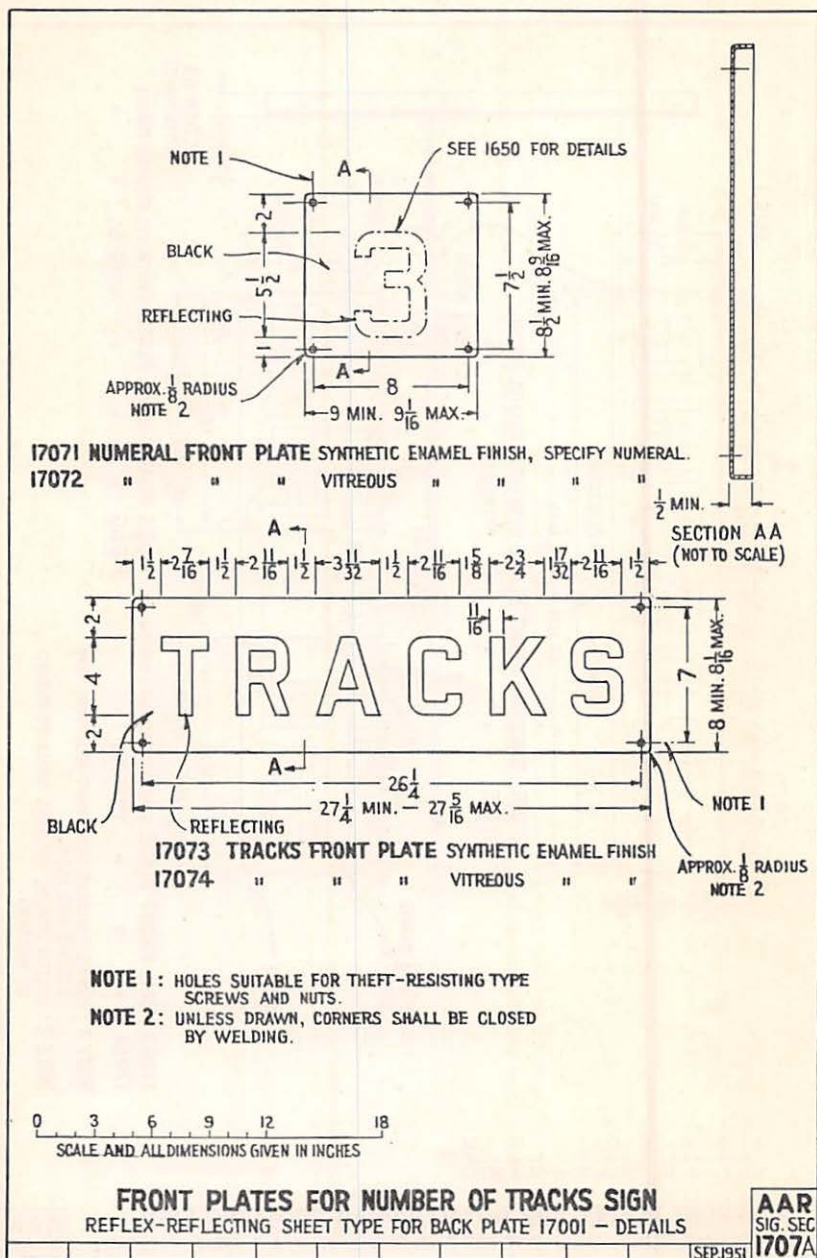
Sept. 1951]



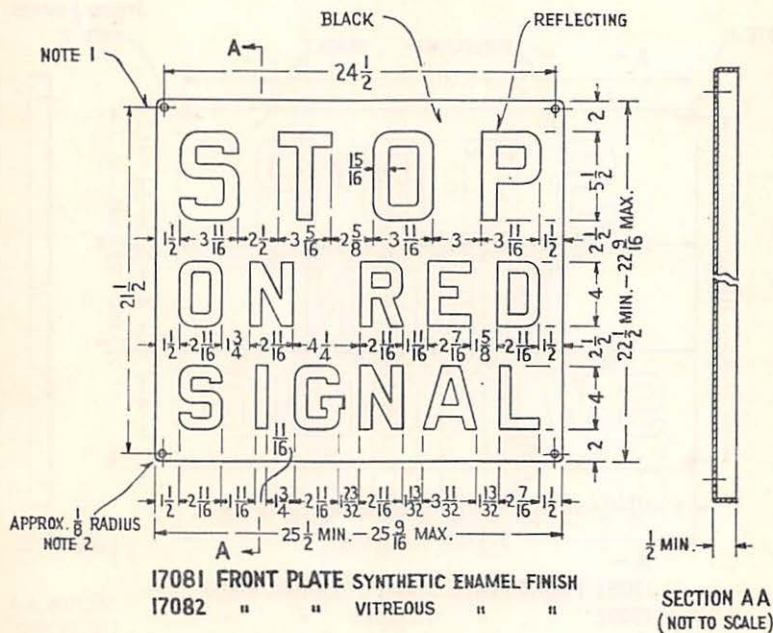


Material, painting and construction shall be in accordance with Specification 155,
Manual Part 44.

SEP 1951
AAR
SIG SEC
17054



Material, painting and construction shall be in accordance with Specification 155,
Manual Part 44.



NOTE 1: HOLES SUITABLE FOR THEFT-RESISTING TYPE
SCREWS AND NUTS.

NOTE 2: UNLESS DRAWN, CORNERS SHALL BE CLOSED
BY WELDING.

0 3 6 9 12 18
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

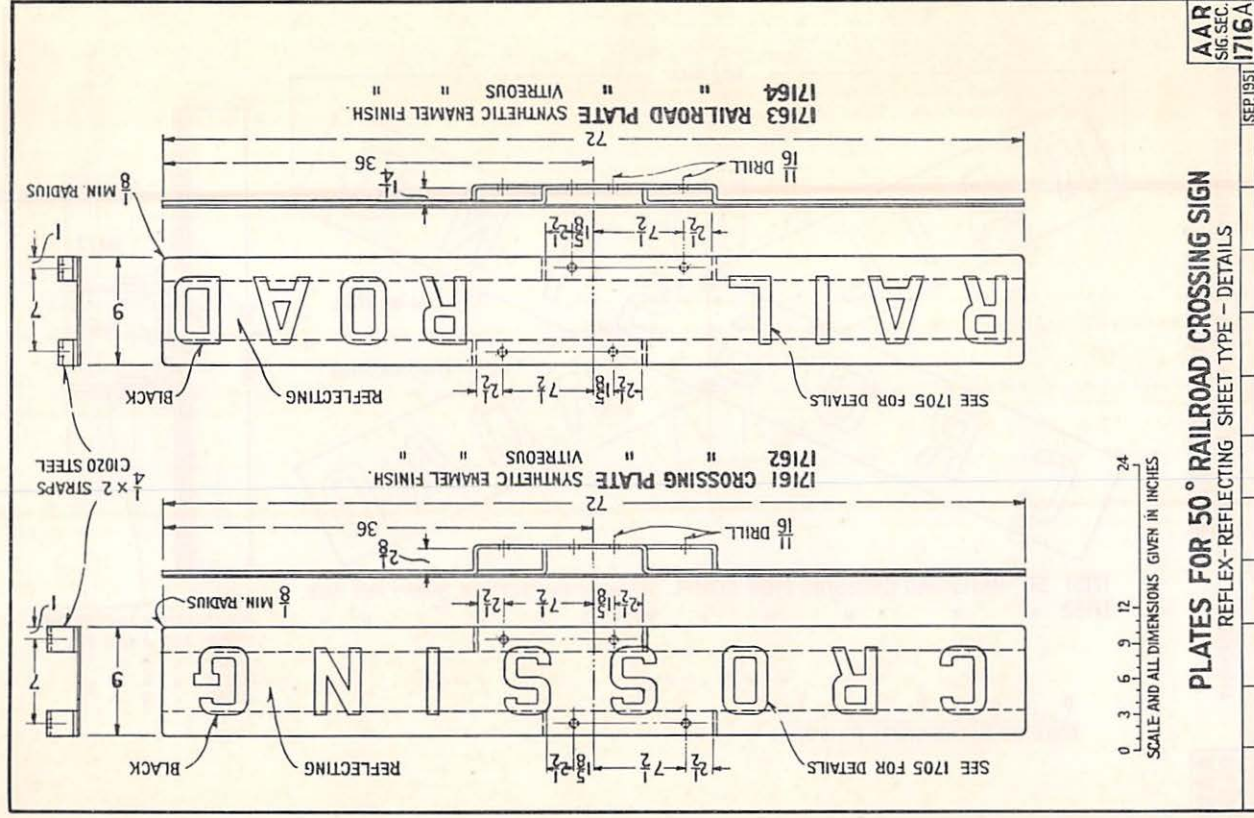
FRONT PLATE FOR STOP ON RED SIGNAL SIGN
REFLEX-REFLECTING SHEET TYPE FOR BACK PLATE 17021 — DETAIL

AAR
SIG. SEC.
1708A

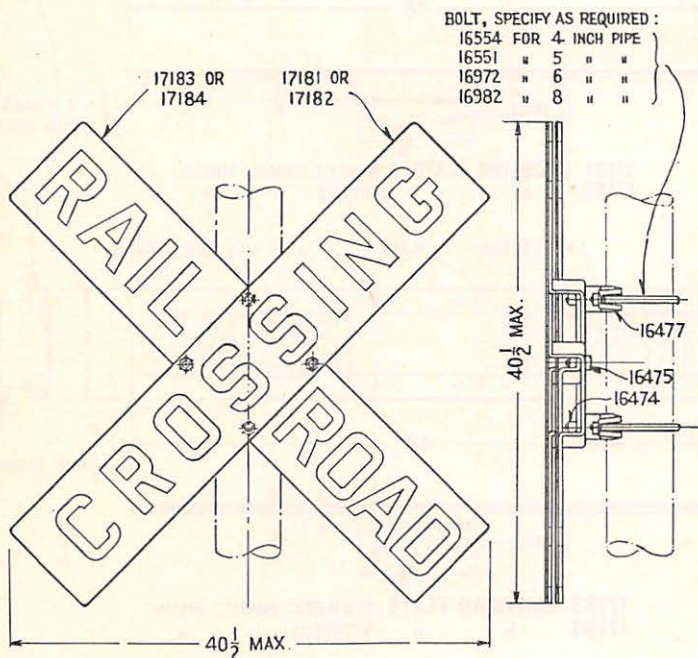
SEP. 1951

Material, painting and construction shall be in accordance with Specification 155,
Manual Part 44.

[Sept. 1951



Material, painting and construction shall be in accordance with Specification 155, Manual Part 44.



17171 90° RAILROAD CROSSING SIGN COMPL. SYNTHETIC ENAMEL FINISH, SPECIFY PIPE SIZE.

17172 " " " " " VITREOUS " " " " "

0 3 6 9 12 24

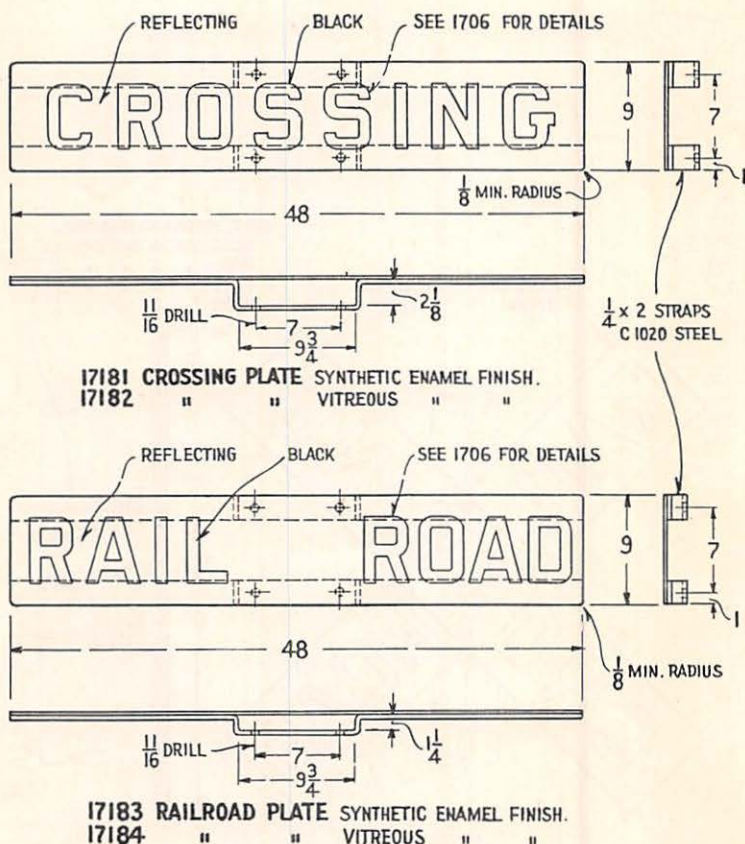
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

90° RAILROAD CROSSING SIGN

REFLEX-REFLECTING SHEET TYPE FOR 4 TO 8 INCH PIPE - ASSEMBLY

AAR
SIG SEC.
1717A

SEP 1951



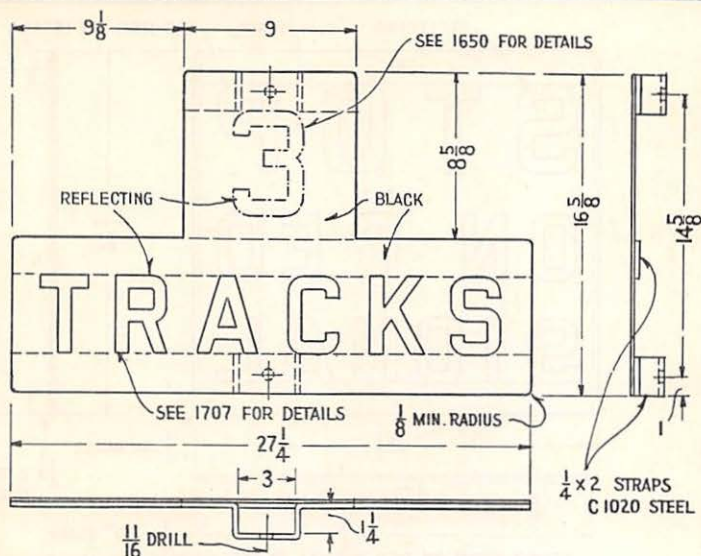
0 3 6 9 12 24
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

PLATES FOR 90° RAILROAD CROSSING SIGN
REFLEX- REFLECTING SHEET TYPE - DETAILS

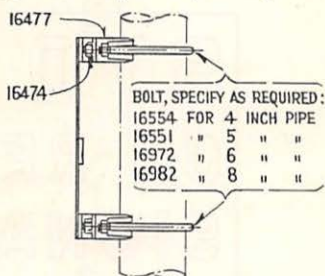
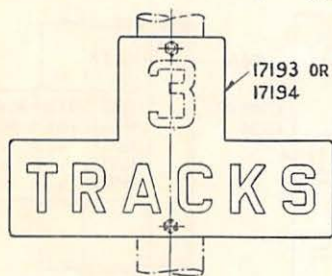
AAR
SIG. SEC
1718A

SEP. 1951

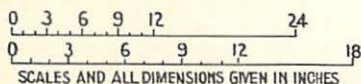
Material, painting and construction shall be in accordance with Specification 155,
Manual Part 44.



17193 NUMBER OF TRACKS PLATE SYNTHETIC ENAMEL FINISH, SPECIFY NUMERAL
17194 " " " " VITREOUS " " " "



17191 NUMBER OF TRACKS SIGN COMPL. SYNTHETIC ENAMEL FINISH, SPECIFY NUMERAL AND
17192 " " " " VITREOUS " " " " [PIPE SIZE]



NUMBER OF TRACKS SIGN

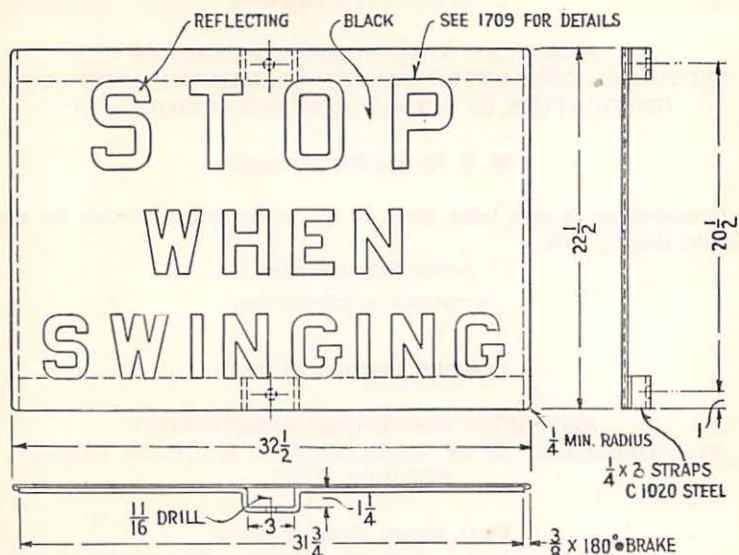
REFLEX-REFLECTING SHEET TYPE FOR 4 TO 8 INCH PIPE - DETAIL AND ASSEMBLY

AAR
SIG. SEC.
1719A

SEP. 1951

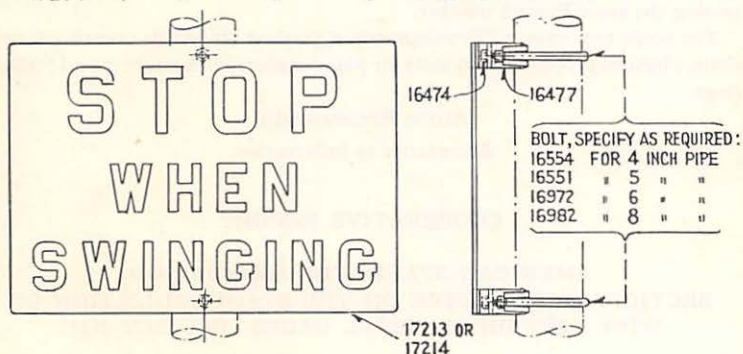
Material, painting and construction shall be in accordance with Specification 155,
Manual Part 44.

Sept. 1951]



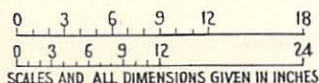
17213 STOP WHEN SWINGING PLATE SYNTHETIC ENAMEL FINISH.

17214 " " " " VITREOUS " "



17211 STOP WHEN SWINGING SIGN COMPL. SYNTHETIC ENAMEL FINISH, SPECIFY PIPE SIZE.

17212 " " " " VITREOUS " " " " " "



STOP WHEN SWINGING SIGN

REFLEX-REFLECTING SHEET TYPE FOR 4 TO 8 INCH PIPE — DETAIL AND ASSEMBLY

AAR
SIG. SEC
1721A

SEP. 1951

Material, painting and construction shall be in accordance with Specification 155,
Manual Part 44.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
SECTIONAL COMMITTEE ON THE STANDARDIZATION AND
UNIFICATION OF SCREW THREADS—PROJECT B1*

W. G. Brown, Representative

Consideration is now being given to the unification of threads for sizes smaller than $\frac{1}{4}$ inch.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
STANDARDIZATION OF WASHERS AND MACHINE RINGS—
PROJECT B27**

W. G. Brown, Representative

The above is a new title, changed from "Plain and Lock Washers" but retaining the same Project number.

The scope now covers "Development of product standards covering dimensions, physical properties and tests for plain washers, lock washers and retainer rings.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
SECTIONAL COMMITTEE ON THE STANDARDIZATION OF
WIRE AND SHEET METAL GAGES—PROJECT B32†

A. S. Haigh, Representative of Engineering Division, A.A.R.

The Committee, which had been inactive for some time, was reactivated early in 1950.

Action Recommended

Acceptance as information.

* Previous report on Project B1 appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 196 and 338.

** Previous report on Project B27 appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 197 and 339.

† Previous report on Project B32 appears in A.A.R. Signal Section 1941 Proceedings, Vol. XXXIX, pp. 158 and 221.

COMMITTEE VII—MATERIALS RESEARCH

Personnel

E. A. Burgin, Chairman

K. Chamberlain, Vice-Chairman

F. E. Beutler	Curtis Kies
J. P. Coleman	J. I. Kirsch
A. L. Essman	C. T. Marak
G. E. Goepfert	J. A. Moore
T. T. Hart	L. B. Sinclair
W. W. Hartzell	P. A. Starck
C. W. Hoffman	T. B. Thompson
J. C. Hoffman	W. K. Waltz

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Investigate and report on rust preventives, segregating into classifications.
4. Investigate and report on means for determining colors for target enamel covered in Specification 227, Manual Part 235, and prepare recommended colors.
5. Investigate and report on the use of stainless steel guy and messenger strand.
6. Investigate and report on a substitute for wood for use on electric crossing gate arms.
7. Investigate and report on test installations of aluminum or newer or better steel alloys for relay and instrument housings.
8. Investigate and report on materials and methods for identification of wiring.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification 144-39, Manual Part 80.
Revision of Specification 120-50, Manual Part 110.
Revision of Specifications for Various Types of Steel, Manual Part 154.
6. Substitute for wood for use on electric crossing gate arms.
7. Test installations of aluminum or newer or better steel alloys for relay and instrument housings.
8. Materials and methods for identification of wiring.
Cooperative report. American Standards Association—Electrical Insulating Materials in General—Project C59.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

- A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.
A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.
S.A.E.—Society of Automotive Engineers, 29 W. 39th St., New York 18, N. Y.
A.I.S.I.—American Iron & Steel Institute, 350 Fifth Ave., New York 1, N. Y.

Disposition of 1950 Letter Ballot Subjects

The following subjects presented by Committee VII at the 1950 Annual Meeting were submitted to letter ballot and officially approved:

- Specification 201-50—Primer Paint, Red Lead Base, for Steel and Iron Structures—Now in Manual Part 65.
Specification 46-50—Transformer Oil—Now in Manual Part 108.
Specification 120-50—Paint and Painting—Now in Manual Part 110.
Specification for Signal Colors Exclusive of Signal Glasses—Now in Manual Part 273.
Specification for Gray Iron Castings—Now in Manual Part 88.
Specification for Malleable Iron Castings—Now in Manual Part 89.
Specifications for Various Types of Non-Ferrous Metals and Alloys—Now in Manual Part 220.

(Revision of A.A.R. Signal Section Specification 144-39)
A.A.R. SIGNAL SECTION SPECIFICATION 144-51.

DRY PROCESS PORCELAIN INSULATION

1. *Purpose.*

(a) This specification is for the purpose of providing dry process porcelain for electrical insulation of signal apparatus which is to be enclosed in housings for circuits of 660 volts or less. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *Requirements.*

(a) Material shall be of the best commercial grade so as to provide a homogeneous body or mass, which shall be close-grained, hard, tough, dense and uniform throughout.

(b) The product shall be free from sharp edges, projections, checks, flaws, cracks, chips, holes, laminations, metallic substances, or other irregularities or defects due to improper or imperfect mechanical treatment, faulty drying or firing, inconsistent with the best commercial manufacture.

(c) Color of product shall be clean white, unless otherwise specified by the Purchaser.

(d) Surfaces of the product shall be glazed or unglazed as specified by the Purchaser. No other surface treatment shall be used. The glaze shall be smooth, bright, firmly adherent, thoroughly vitrified and free from bubbles, cracks, checks, crazing or undissolved particles and shall be continuous over the specified portion of the surface.

(e) The glaze shall not contain injurious proportions of lead oxide or lead salts, and shall have as nearly as possible the same coefficient of expansion as the porcelain.

5. *Requirements.*—Continued.

(f) Finished parts shall conform to dimensions and tolerances specified by the Purchaser. When tolerances are not specified by the Purchaser, a tolerance of 1.5 per cent, plus or minus, will be allowed.

(g) When tested in accordance with section 7-e, water absorption shall not exceed 1 per cent of the dry weight.

6. *Inspection.*

(a) Purchaser may inspect the material or product at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If product has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

7. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when the product will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate what portion of the product shall be tested.

(e) Test for water absorption shall be conducted as follows:

1. Samples of finished parts, selected at random, shall be broken for the test into fragments of approximately 1 cu. inch in volume. If finished parts are glazed, at least 75 per cent of the area of the fragments shall be free from glaze or other surface treatment. The test fragments shall be dried at a temperature of not less than 230 deg. F. to a constant weight.

2. Test fragments shall then be boiled in distilled water for 2 hours and allowed to cool in this water to room temperature.

3. Upon being removed from the water the fragments shall be wiped dry and weighed individually.

4. The constant weight as determined in section 7-e-1 shall be subtracted from the weight determined in section 7-e-3. This is the increase in weight. The increase in weight of the fragments divided by their dry weight times 100 equals the per cent water absorption.

8. *Packing.*

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

9. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

10. *Warranty.*

(a) Manufacturer shall warrant the product covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 1 year after shipment to the Purchaser. This warranty shall not apply to any product which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 144-39—Dry Process Porcelain Insulation,
Manual Part 80.

(Revision of A.A.R. Signal Section Specification 120-50)
A.A.R. SIGNAL SECTION SPECIFICATION 120-51.

PAINTING

1. *Purpose.*

(a) This specification is for the purpose of setting forth the use of paint and the method of its application.

2. *Specifications and drawings.*

(a) Specifications and drawings referred to in the body of this specification form an essential part hereof.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *General.*

(a) Paint prescribed for application to apparatus as covered in this specification shall be in accordance with the following:

1. Primer paints.

(a) Primer Paint, Red Lead Base, for Steel and Iron Structures—Specification 201, Manual Part 65.

(b) Primer Paint for Wood Structures—Specification 238, Manual Part 246.

(c) Enamel Primer Paint for Steel and Iron Structures—Specification 237, Manual Part 245.

2. Finishing paints and enamels.

(a) Aluminum Paint Suitable for Finishing Coats on Steel Structures—Specification 200, Manual Part 62.

(b) Non-Reflecting Black Coating Material for Backgrounds of Signals Employing Lights—Specification 214, Manual Part 221.

(c) Target Enamel—Specification 227, Manual Part 235.

(d) Paint for Finishing Coats on Wood Structures—Specification 251, Manual Part 264.

(e) Paint for Finishing Coats on Steel and Iron Structures—Specification 252, Manual Part 265.

(f) Enamel Paint for Finishing Coats on Wood Structures—Specification 253, Manual Part 266.

(g) Paint and Painting of Braid-Covered Aerial

5. *General*.—Continued.

Wires and Cables—Cable Paint—Volatile Thinner—
Specification 181, Manual Part 151.

(h) Paint and Painting of Braid-Covered Aerial
Wires and Cables—Cable Paint—Asphalt or Coal Tar
Emulsion—Specification 187, Manual Part 152.

6. *Mixing and thinning*.(a) *Mixing*.

1. Paint shall be thoroughly mixed before applying, or an inferior paint coating will result. To provide thorough mixing, the following procedure should be followed:

(a) Pour off a portion of the liquid into another container.

(b) Stir the paint left in the original container, then add all the liquid previously poured off, stirring constantly as it is being added.

(c) Pour the contents from one container to another enough times to provide a homogeneous mixture.

(b) *Thinning*.

1. For the thinning of primers, paints and enamels, for application by brushing, spraying or dipping, Manufacturer's directions shall be followed, and the specified thinners used.

7. *Cleaning*.

(a) Surfaces shall be thoroughly cleaned. All loose or detachable mill scale, paint, rust, grease, dirt or other foreign substances shall be removed and surfaces shall be thoroughly dried before painting.

8. *Application*.

(a) Paint may be applied by brushing, dipping or spraying and may be air dried or baked.

(b) Paint shall be well mixed, uniformly applied with special attention given to providing adequate protection at joints and crevices, and each coat shall be dry before application of succeeding coats.

(c) Paint shall not be applied to surfaces when ambient temperature is below 45 deg. F.

(d) Surfaces that will be inaccessible after assembly or after erection shall be given a priming coat and where practicable specified finishing coats of product before assembly and erection.

(e) Surfaces that will be inaccessible after installation and which may be subjected to extreme moisture conditions shall be given an additional coating of rust-preventive material as specified by the Purchaser.

(f) Before shipment from point of manufacture, all parts and equipment requiring paint shall be given the primer coat and, when specified by Purchaser, the finished coats in accordance with section 9.

9. Prescribed paint coatings.

(a) Sheet metal housings, instrument shelters, battery cases, boxes, bungalows and other sheet metal structures for outdoor installation shall be painted as follows:

1. Exterior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of aluminum paint, Specification 200, Manual Part 62. *R-9-a-1.

2. Interior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint, Specification 252, Manual Part 265, of Manufacturer's standard color. *R-9-a-2.

(b) Sheet metal cabinets, tower cases, chaseways, interlocking and control machine cabinets and cases for indoor installation shall be painted as follows:

1. Exterior surfaces shall be given one coat of enamel primer, Specification 237, Manual Part 245, followed by two coats of target enamel, Specification 227, Manual Part 235, color to be as specified by the Purchaser. *R-9-b-1.

2. Interior surfaces shall be given one coat of enamel primer, Specification 237, Manual Part 245, followed by one coat of target enamel, Specification 227, Manual Part 235, of Manufacturer's standard color. *R-9-b-2.

(c) Interlocking and control machine parts (except levers and machine-finished surfaces) shall be given one coat of enamel primer, Specification 237, Manual Part 245, followed by one coat of target enamel, Specification 227, Manual Part 235, colors to be as specified by Purchaser. *R-9-c.

(d) Levers for interlocking and control machines (except machine-finished surfaces and latch handles) shall be given two coats of target enamel, Specification 227, Manual Part 235, colors to be as specified by Purchaser. *R-9-d.

(e) Metal hoods and backgrounds of signals employing lights shall be given one coat of primer, Specification 201, Manual Part 65, followed by one coat of non-reflecting black coating material, Specification 214, Manual Part 221. *R-9-e.

(f) Sheet metal targets, signal blades, signs, etc., shall be given one coat of enamel primer, Specification 237, Manual Part 245, followed by one coat of target enamel, Specification 227, Manual Part 235, colors to be as specified by Purchaser. *R-9-f.

(g) Structural steel and iron parts, such as signal ladders, masts, bridges, brackets, platforms, etc., shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint, Specification 252, Manual Part 265, colors to be as specified by Purchaser. *R-9-g.

(h) Steel pipe for signal poles and cable posts shall be painted as follows:

1. Interior surface of pipe shall be given one coat of primer, Specification 201, Manual Part 65. *R-9-h-1.

* Alternate requisites section.

9. *Prescribed paint coatings.*—Continued.

2. Exterior surface of pipe shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint, Specification 252, Manual Part 265, colors to be as specified by Purchaser. *R-9-h-2.

(i) Iron and steel castings such as car retarder parts, switch machine, circuit controller and switch lock cases; signal mechanism and relay cases; housings and cases for train control equipment, motor frames and housings, switch stands, pole bases (except machine-finished surfaces), etc., shall be painted as follows:

1. Exterior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by two coats of paint, Specification 252, Manual Part 265, colors to be as specified by Purchaser. *R-9-i-1.

2. Interior surfaces shall be given one coat of primer, Specification 201, Manual Part 65, followed by one coat of paint, Specification 252, Manual Part 265, of Manufacturer's standard color. *R-9-i-2.

(j) Signal pipe and forgings, bars, rods, bolts, such as car retarder and switch machine parts, etc. (except machine-finished surfaces) shall be given one coat of primer, Specification 201, Manual Part 65, followed by one coat of paint, Specification 252, Manual Part 265, colors to be as specified by Purchaser. *R-9-j.

(k) Wood housings for outdoor installation shall be painted as follows:

1. Exterior surfaces shall be given one coat of primer paint, Specification 238, Manual Part 246, followed by two coats of paint, Specification 251, Manual Part 264, colors to be as specified by Purchaser. *R-9-k-1.

2. Interior surfaces shall be given one coat of primer paint, Specification 238, Manual Part 246, followed by one coat of enamel, Specification 253, Manual Part 266, of Manufacturer's standard color. *R-9-k-2.

(l) Wood arms for highway grade crossing gates shall be given one coat of primer paint, Specification 238, Manual Part 246, followed by two coats of paint, Specification 251, Manual Part 264, color and striping to conform to Drawing 1491, 1492, 1493 or 1494. *R-9-l.

(m) Braid-covered aerial wires and cables exposed to and not inherently protected against open weather conditions shall, at time of installation, be given two coats of cable paint, Specification 187, Manual Part 152. *R-9-m.

* Alternate requisites section.

10. *Removable protective coating.*

(a) Before shipment or exposure to dampness, machine-finished surfaces shall be coated with a white lead and tallow compound, or an equivalent which shall have sufficient body to resist weather and rusting. Coating materials shall be non-injurious to metal parts and such as to permit ready removal by wiping, stripping or use of a non-injurious solvent.

11. *Warranty.*

(a) Manufacturer shall warrant the painting covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to repainting any part or parts which shall be found defective within a period of 1 year.

Alternate requisites.

R-9-a-1.

Exterior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-a-2.

Interior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-b-1.

Exterior surfaces shall be given coats of primer, followed by coats of, color to be

R-9-b-2.

Interior surfaces shall be given coats of primer, followed by coats of, color to be

R-9-c.

Interlocking and control machine parts (except levers and machine-finished surfaces) shall be given coats of primer, and coats of, color to be

R-9-d.

Levers for interlocking and control machines (except machine-finished surfaces and latch handles) shall be painted with coats of target enamel, Specification 227, Manual Part 235, colors to be as specified below:

	Name of lever	Color
1.		
2.		

Alternate requisites.—Continued.

R-9-e.

Metal hoods and backgrounds of signals employing lights shall be given coats of primer, followed by coats of non-reflecting black coating material, Specification 214, Manual Part 221.

R-9-f.

Sheet metal targets, signal blades, signs, etc., shall be given coats of primer, followed by coats of target enamel, Specification 227, Manual Part 235, colors to be as specified below:

Description	Color
1.	
2.	

R-9-g.

Structural steel and iron parts, such as signal ladders, masts, bridges, brackets, platforms, etc., shall be given coats of primer, followed by coats of paint, color to be

R-9-h-1.

Interior surface of pipe shall be given coats of primer.

R-9-h-2.

Exterior surface of pipe shall be given coats of primer, followed by coats of color to be

R-9-i-1.

Exterior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-i-2.

Interior surfaces shall be given coats of primer, followed by coats of paint, color to be

R-9-j.

Signal pipe and forgings, bars, rods, bolts, such as car retarder and switch machine parts, etc. (except machine-finished surfaces) shall be given coats of primer, followed by coats of paint, color to be

Alternate requisites.—Continued.

R-9-k-1.

Exterior surfaces shall be given coats of
primer, followed by coats of paint, color
to be

R-9-k-2.

Interior surfaces shall be given coats of
primer and coats of, color to be

R-9-l.

Wood arms for highway grade crossing gates shall be given
..... coats of primer, followed by
coats of, color to be

R-9-m.

Braid-covered aerial wires and cables exposed to and not
inherently protected against open weather conditions shall, at
time of installation, be given two coats of cable paint, Specifica-
tion 181, Manual Part 151.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded
Specification 120-50—Paint and Painting,
Manual Part 110.

MATERIALS AND METHODS FOR IDENTIFICATION OF WIRING

A questionnaire (Inquiry SS-93A), containing 31 questions, was issued to Voting Representatives of 149 Member Roads in the Signal Section on June 23, 1950.

Twenty-one of the questions required specific information on the type and shape of tag used, material from which made, manner in which attached to the wire, and method of marking employed. Of the other questions asked, 3 related to color coding of wires, and one sought information as to whether or not the user required the materials to be flame-resistant.

Replies were received from 105 railroads. A summary of the replies received indicates the following: 103 railroads use flat tags of black fibre material, rectangular in shape; 93 railroads use rectangular tags with one hole, and 24 use rectangular tags with two holes. Tags are slipped on the wire in 83 instances, 22 are tied on, and 26 attached by other means, such as under binding post nuts, or fastened to the terminal board by escutcheon pins. In 93 instances the tags are marked by stenciling or stamping, a few others by printing or writing.

In addition to using the rectangular fibre tag, 5 of the railroads report the use of tube tags—three made of fibre, the other two of plastic. Thirty-two railroads use wrap-around tags—19 of these are the Quik-Label and 13 the E Z Code marker. Nine railroads report use of the snap-on type made of plastic. Thirteen railroads report use of round aluminum or brass tags on cross-arms of pole lines to identify circuits on the pole line.

Nineteen railroads report using color coding as a means of wire identification, 72 do not employ color coding. Of the 19 cases of color coding, 18 are confined to colored braids.

Only 31 of the railroads answered the question, "Do you require the materials to be flame-resistant?" Eleven replied that they do in centralized traffic control buildings and interlocking stations only; 20 report that they do not.

A few of the railroads report the use of stamping machines for marking tags; however, this may not accurately portray the amount of machines in use since no direct question was asked concerning this matter.

The foregoing information clearly indicates the prevailing practices concerning the materials and methods presently employed. It is believed that a greater use of color coding, by colored tags or colored braid, could be advantageously employed. Distinctive colors may be used to indicate positive or negative voltages in lieu of present stenciling methods, thus reducing the amount of labor presently required for marking tags. The labor involved in the hand marking of tags is much greater than is generally recognized, and it is the opinion that a greater utilization of machines would produce a considerable saving.

Action Recommended

Acceptance as information.

SUBSTITUTE FOR WOOD FOR USE ON ELECTRIC
CROSSING GATE ARMS*Basic Requirements for Gate Arms*

When considering the practicability of various materials for use in the manufacture of electric crossing gate arms, it is very important to give full consideration to the requirements of the service to which the completed arm will be put as well as to matters relating only to the material itself. The following is a brief statement of the basic requirements of electric crossing gate arms:

Cost.

Reasonable first cost is a very important requirement, but in the case of some materials, a higher first cost may be justified by lower maintenance costs. Maintenance costs should be low and to that end, crossing gate arms should be resistant to or readily protected from corrosion and the effects of normal weather conditions and temperatures between minus 40 degrees and 185 degrees F. In order to keep repair and replacement costs low, gate arms should be readily repairable in the field, preferably by means of replacement sections or parts and without the use of skilled employees or heavy and expensive equipment. Counterweighting is an important item in the over-all cost of electric crossing gates and crossing gate arms should be light in weight in order to minimize counterweighting requirements.

Compatibility.

Electric crossing gate arms must be suitable for attachment to get operating mechanism, per Specification 199, Manual Part 194.

Appearance.

Crossing gate arms, in any position, must be plainly visible and recognizable from the highway approaching the crossing. The outer surfaces of crossing gate arms must be suitable for striping in accordance with Drawing 1491. The material and design of crossing gate arms must be such as to permit the application of reflector units, reflecting material and gate lamps with associated wiring, as required by Specification 199, Manual Part 194.

Special features.

The material and design of crossing gate arms should be such that the arms cannot be permanently bent parallel to the highway or across the tracks. Gate arms should break without damage to the operating mechanism when struck by a vehicle, but should be strong enough to withstand the effects of high winds and such weather conditions as are normally encountered. The ends of broken gate arms should be blunt so as not to endanger pedestrians or the occupants of trains or highway vehicles. Broken gate arms should not be hazardous to train operation. Gate arms should be capable of being dismantled in convenient lengths for shipping and the external surfaces should be limited in extent and of such a nature as to minimize ice loading.

Wood for Gate Arms

To a large extent, the foregoing requirements are met by gate arms constructed of lightweight short grain lumber such as white pine, Grade C Select, or better, but due to the increasing scarcity and steadily rising costs of this grade of pine, heavier and less suitable wood such as Ponderosa and Sugar Pine are being used in the majority of cases. The use of heavier lumber results in:

1. Additional counterweighting.
2. Increased mechanism wear.
3. Slower gate operation.
4. Increased breakage.
5. Increased power requirements.

The repainting of wooden gate arms and the replacement of deteriorated or unsightly members results in high maintenance costs.

Substitutes for Wood for Gate Arms

Case No. 1.

In 1929, one railroad installed six gates with metal arms at three crossings in the Chicago area and these are still in service. The gate arms are 16 feet in length and made up of five sections of heat treated aluminum alloy tubing welded together with slip joints. The wall thickness of the tubing is $\frac{1}{4}$ inch. The first section of tubing has an inside diameter of 4 inches and is screwed into a collar attached to the gate arm support. The inside diameters of the second, third, fourth and fifth sections of tubing are $3\frac{1}{2}$, 3, $2\frac{1}{2}$ and 2 inches, respectively.

The gate arm supports are fabricated from 6-inch structural channels and swing on rotating posts when the gate is struck. The gate arms are painted black and white with spiral stripes. Gate lamps are attached to the gate arms with $\frac{3}{4}$ inch pipe nipples and the wires are run inside the hollow gate arms. No galvanic action has been experienced and while no complete record has been kept, there has been very little breakage. The three crossings carry only light vehicular traffic and the railroad traffic consists of approximately 85 trains per day operating at speeds up to 50 miles per hour.

Case No. 2.

One supplier of magnesium alloys recommends extruded sections of magnesium alloy for the fabrication of crossing gate arms. These extruded sections could be fabricated and assembled to form tapered gate arm sections. This alloy would require protection from corrosion by painting and would have to be prepared for painting by treatment with a special chromate dip.

When this alloy is assembled with other metals, precautions must be taken to avoid galvanic action. However, the magnesium alloy can be assembled with aluminum of the proper alloy without adverse effects. If assembled with steel, an insulating gasket, made of tape or sheet material must be installed between the steel and the magnesium. This gasket should extend a minimum of $\frac{1}{8}$ inch outside the joint. Steel bolts if used with magnesium alloy should be cadmium or zinc-plated.

Case No. 3.

One supplier of aluminum recommended inverted "U" sections of aluminum alloy sheet for the fabrication of crossing gate arms, and submitted a suggested

design that resembles the standard wooden gate arm. The suggested design provided for the gate arm sections to be fastened together with blocks of wood which would break upon impact.

The aluminum alloy sheet recommended is 61S-T6 with a thickness of from 0.040 to 0.102 inch. Prior to shop painting, the surface should be given a chemical cleaning or be coated with a wash coat primer. Galvanic action due to assembling aluminum with dissimilar metals could be avoided by the use of aluminum alloy bolts, nuts and screws. If steel fastenings are used they must be cadmium or zinc plated.

Case No. 4.

In August 1949, one manufacturer built a gate arm of standard one-half hard aluminum sheet 0.031 inch thick. The arm is 31 feet 6 inches long and has an appearance similar to a standard wooden arm. Each longitudinal member of the arm consists of a single sheet with the upper and lower edges rolled to form 1 inch tubes. After 2 months outdoors, this arm was blown down in a wind storm, then the butt of the arm was reconstructed of 0.062 inch sheet and no trouble has been experienced since. The aluminum was properly prepared and painted when installed and no galvanic action has been experienced. The aluminum arm weighs approximately 90 pounds. It cost about twice as much as a wooden arm.

Case No. 5.

One manufacturer built a 38-foot gate arm of sheet steel with the appearance and shape of a standard wooden arm. This was discarded as it had no advantage over the wooden arm, being heavier and more expensive. This same manufacturer then built a 20-foot gate arm using magnesium alloy sheet 0.020 inch thick and shaped like a standard wooden gate arm. The weight was 16 pounds and it was strong enough to support 200 pounds at the center of a 10-foot span without any noticeable sag. The gate arm was placed in continuous operation on the roof of the factory for 1 year and no trouble was experienced. However, the cost was very high and difficulty was experienced in fabrication.

This same manufacturer, with the assistance of a supplier of aluminum, designed and built a 30-foot gate arm consisting of five identical sections plus a butt section and a tip section. Each of the five identical sections are 5 feet 4 inches in length, this length being a multiple of 16 inches which is the width of the painted stripes and providing interchangeability after painting. The sections consist of two parallel "U" shaped members 7 inches high and $\frac{3}{4}$ inch through, formed from aluminum alloy sheet and spaced 8 inches apart by diagonal sheet aluminum alloy spacers with rolled edges. Channels are used to join the sections and to close the bottom of the "U" shaped members.

The base section fits into a standard gate arm support and tapers from $20\frac{1}{4}$ inches to 8 inches in width. The tip section is merely a rounded end for the arm and is painted white as in standard wooden arms. All sections except the

tip have $4\frac{1}{2}$ inch wood filler blocks in each end of the "U" shaped members. The following table gives the available data concerning the various sections:

Section	Alloy	Sheet thickness, inch	Weight, lbs.
1st (tip)	3S-H14	—	—
2nd	61S-T6	0.025	9.75
3rd	61S-T6	0.025	9.75
4th	61S-T6	0.025	9.75
5th	61S-T6	0.040	—
6th	61S-T6	0.091	—
7th (base)	61S-T6	0.091	—
Joint channels	—	0.040 to $\frac{3}{16}$	—

The sections were originally bolted together with $\frac{1}{4}$ inch aluminum alloy bolts but these were not strong enough and were replaced with $\frac{5}{16}$ inch cadmium plated steel bolts which proved satisfactory pending completion of experiments with stronger aluminum alloy bolts.

The manufacturer reports that this gate arm has an apparent advantage in that most breakage would occur in one of the identical sections and replacement sections could be carried in stock and easily installed. The base section is usually between the mechanism and the curb and would seldom be harmed. The manufacturer reports that a length of 30 feet is about the present maximum for this type of gate arm, but that only 20 per cent of all gate arms are longer than 30 feet. This manufacturer also feels that the design can be improved upon to permit greater length.

One major disadvantage of the arm as constructed is that while its weight is the same as that of a wooden arm of the same length, the center of gravity is farther out thereby increasing the required counterweighting, but the manufacturer believes this can be overcome by a design change. One section of a different design has been made which reduced the weight from $9\frac{3}{4}$ to $5\frac{3}{4}$ pounds without any apparent loss in strength. This was done by making the side pieces with a rolled edge at top and bottom in place of the "U" section. The manufacturer is continuing the work of improving the design of this arm and will possibly use aluminum alloy sheet with rolled edges similar to the re-designed section previously mentioned.

Shop painting is not a problem on these sections, as they are short enough to be treated in a bath before painting, and approved methods of treatment and painting should be perfectly satisfactory.

Action Recommended

Acceptance as information.

(Revision of Specifications for Various Types of Steel)

SPECIFICATIONS FOR VARIOUS TYPES OF STEEL

1951

The recommended specifications for various types of steel shall meet the requirements of the current specifications of the American Iron and Steel Institute as follows (the numbers in parenthesis following each A.I.S.I. number refer to the equivalent specification of the Society of Automotive Engineers):

Specification AISI-C1020 or C1022 (SAE-1020 or 1022) for a general utility grade of open hearth carbon steel suitable for forged and other parts requiring no special physical properties. These steels may be case hardened. C1022 is a high manganese variant of C1020 for the purpose of improving machineability and hardening properties.

Specification AISI-C1035 (SAE-1035) for a steel suitable for forged parts, gears, shafts, rods, etc., which are to be heat-treated and shall apply in the manufacture of rods having sets of 1 inch or more and used with heavy loads, such as slip switches and movable point frogs.

Specification AISI-B1112 or B1113 (SAE-1112 or 1113) for a free machining grade of steel made by the Bessemer process. Steel supplied under the specification reference will ordinarily be "cold-rolled" unless "hot-rolled" is called for. The physical characteristics of the "cold-rolled" material are superior to the "hot-rolled," and in addition, "cold-rolled" will in many instances fill drawing requirements as to finish without further machining. Reference to these specifications, therefore, should also specify "cold-rolled."

Specification AISI-C1118 (SAE-1118) for a steel used extensively for case-hardened parts and where superior machining properties are desired.

Specification AISI-1335 (SAE-1335) for a manganese alloy steel where greater strength and toughness are required than is possible with plain carbon steel but where the conditions do not justify the higher physical properties obtained by the more expensive alloy steel 3130. Specification 1335 steel is primarily an oil hardening steel so great care should be exercised in water quenching.

Specification AISI-3130 (SAE-3130) for a nickel chromium steel suitable for water quenched parts where greater strength and toughness are required than is possible with plain carbon steel.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specifications for Various Types of Steel,
Manual Part 154.

TEST INSTALLATIONS OF ALUMINUM OR NEWER OR
BETTER STEEL ALLOYS FOR RELAY AND
INSTRUMENT HOUSINGS

One railroad reports that six relay housings fabricated from aluminum alloy sheet and plate have been in service in industrial areas for approximately 2½ years. These relay housings have given satisfactory service to date and their present condition indicates that long life may be expected.

Another railroad advises that in the latter part of 1950 they installed in one of their tunnels, where severe gaseous conditions exist, an instrument case made of stainless steel. Due to the short period of service, definite conclusions as to service life expected cannot be arrived at as yet; however, no difficulty was experienced in making the installation.

No other test installations of aluminum or newer or better steel alloys for relay and instrument housings have been reported.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
ELECTRICAL INSULATING MATERIALS IN GENERAL—
PROJECT C59*

J. I. Kirsch, Representative

A meeting of Sectional Committee C59 on Electrical Insulating Materials was held in Cincinnati, Ohio, on November 15, 1950.

It was acknowledged that Mr. R. W. White, Insulation Application Section, Westinghouse Electric Corp., has been appointed by A.S.T.M. Committee D-1, to succeed Mr. W. R. Fuller.

There was only one former American Standard revised during the past year: namely, Standard Methods of Testing Shellac Used for Electrical Insulation (D 411-50). The Committee considered whether this revised Standard should be submitted to letter ballot for reapproval as American Standard.

The 1950 revision concerns the flow test. It was reported that further consideration was being given to this test procedure as concerns the temperature at which the test is made. It was decided to urge Subcommittee 1 of Committee D-9 to complete this further revision of the flow test before considering Method D 411 for reapproval as American Standard.

Consideration was given to additional standards for submittal to the A.S.A. for approval as American Standard. Action was taken to submit the A.S.T.M. Tentative Methods of Test for Electrical Resistance of Insulating Materials (D 257-49T) to letter ballot of C59 for approval as American Standard without review by a review panel. Consideration was given to the Tentative Specifications for Friction Tape for General Use for Electrical Purposes (D 69-48T), and Specifications for Rubber Insulating Tape (D 119-48T).

* Previous report on Project C59 appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 211 and 296.

It was reported that there are still some objections to these specifications in the Signal Section, A.A.R. It was accordingly agreed that these two specifications should be first considered by a review panel of two members. The Chairman appointed a review panel consisting of Messrs. J. I. Kirsch, Chairman, and R. H. Titley. This matter is now in the process of review for decision.

The A.S.T.M. Standard Methods of Testing Electrical Porcelain (D 116-44) were also proposed for consideration. It was decided to have this standard first considered by a review panel consisting of Messrs. H. A. Anderson, Chairman, and A. H. Scott.

The Chairman reported that letters had been received from the A.I.E.E. and from the A.A.R. advising that these groups had no standards to submit at this time for consideration or approval as American Standards.

Mr. Kirsch reported that the Signal Section would give further consideration to this matter during the coming year, and he would present a report at the next Annual meeting.

Mr. E. F. Seaman of the Bureau of Ships, Navy Department, reported that further consideration had been given to the JAN Standards previously submitted, and it was believed these were perhaps not appropriate for consideration for approval as American Standards. It was also reported that the Electrical Standards Committee has this matter under consideration. Since these involve a matter of policy, the Secretary of the Sectional Committee will take the matter up with the Electrical Standards Committee.

It was agreed that the Committee should not endeavor to maintain an up-to-date list of available standards dealing with electrical insulation. It was brought out that the various associations issuing such standards make available annually a list of their publications. It was felt that these lists would furnish the needed information and that a composite list would be too difficult to maintain.

The following reports were presented regarding the International discussion on standards and insulated materials:

(a) Mr. F. M. Clark reported that he attended an I.E.C. meeting in Stresa, Italy in 1949, at which a working committee on sludge formation in transformer oils was appointed. Mr. Clark is a member of this committee and was obtaining copies of sludge testing methods used in this country for consideration by the I.E.C. Samples of transformer oil used in various countries are also being circulated for cooperative testing in various laboratories.

(b) Mr. Houseman reported that the A.S.T.M. and N.E.M.A. have reviewed a method of grading and classifying mica. Much progress has been made but other important factors of the proposed standard are being considered. The proposed set of color transparencies for grading mica cannot be reproduced satisfactorily. While this has been disappointing the Committee is now giving consideration to obtaining sets of reference standards using specially selected pieces of mica.

(c) A report by letter was received from Mr. C. C. Hartman regarding the international discussions on shellac. The three proposed draft specifications covering seedlac, shellac, and dry bleached shellac, have been reviewed by the American Committee and comments have been submitted to the I.S.O. Committee.

Sept. 1951]

Committee VII—Materials Research

(d) Mr. Seaman reported that at the meeting in Paris he presented to the I.E.C. a copy of the compilation of "A.S.T.M. Standards on Electrical Insulation Material." He also emphasized the need for the Committee to work on other outlined projects.

Sectional Committee C59 believes that the I.E.C. Committee should give consideration to the items listed on this diagram which is intended as a guide representative of the thinking in the United States covering the international standardization of such a project in the field of insulating materials.

Action Recommended

Acceptance as information.

COMMITTEE VIII—HIGHWAY GRADE CROSSING PROTECTION

Personnel

W. H. Stilwell, Chairman	
H. T. Fleisher, Vice-Chairman	
H. A. Appleby	R. H. Smedley
P. H. Foley	W. R. Smylie
S. B. Higginbottom	J. G. Stonehouse
J. E. K. Krylow	C. H. Tillet
S. W. Law	J. L. Weatherby
B. F. McGowan	L. S. Werthmuller
H. G. Morgan	A. W. Wilson
W. F. Price	H. D. Blake*
H. C. Sampson	R. B. Elsworth*
E. J. Seybold	H. A. Franklin*
L. McNally*	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on any development on highway grade crossing protection.
4. Investigate and report on the use of diffusing lenses in electric light units for highway crossing signals to provide a wider range of indication where a long view is not required.
5. Prepare typical location plans for highway grade crossing protection devices.
6. Investigate and report on the durability and methods of maintenance of reflectorized signs.
7. Investigate and report on methods for focusing and aligning railroad highway grade crossing flashing light signals in the field.
8. Investigate and report on the use of reflecting materials for backgrounds on signs covered by Drawings 1491, 1642, 1643, 1645, 1646, 1648, 1691, 1692 and 1693, collaborating with A.R.E.A. Committee 9.

Disposition of 1950 Letter Ballot Subjects

The following subjects presented by Committee VIII at the 1950 Annual Meeting were submitted to letter ballot and officially approved:

Requisites for Control of Automatic Highway Grade Crossing Signals and Devices—Now in Manual Part 274.

Requisites for Automatic Gates—Now in Manual Part 35.

Requisites for Highway Grade Crossing Signals—Now in Manual Part 148.

Requisites for "No Right Turn" and "No Left Turn" Signals—Now in Manual Part 224.

Specification 209-50—Highway Grade Crossing Automatic Gates—Now in Manual Part 179.

* Consulting Member.

COMMITTEE IX—OVERHEAD AND UNDERGROUND LINES

Personnel

G. C. Felton, Chairman

W. W. Beard, Vice-Chairman

H. H. Cooper

V. O. Smeltzer

R. W. Margsh

R. C. Steele

M. A. Nyberg

E. P. Stephenson

R. H. Smedley

C. L. Summers

W. M. Vogts

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Performance specification for solderless type connectors for making line connections (various size conductors).
4. Investigate and report on wire used in instrument cases and housings, panel and interlocking machines and track model boards.
5. Investigate and report on the difficulties experienced with Signal Section specifications parkway type track wire protective coverings and if found desirable recommend something physically stronger which will better withstand roadway stresses encountered.
6. Investigate and report on extent of failures in Signal Section specifications underground cables attributed to damage caused by rodents, micro-organisms or termites and recommend protection against such damage.

The Committee submits for consideration, reports on the following subjects*:

5. Investigation on difficulties experienced with Signal Section specifications parkway type track wire protective coverings.
6. Investigation on extent of failures in Signal Section specifications underground cables attributed to damage caused by rodents, micro-organisms or termites.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

Disposition of 1950 Letter Ballot Subjects

The following subjects presented by Committee IX at the 1950 Annual Meeting were submitted to letter ballot and officially approved:

- Specification 145-50—Single and Multiple-Conductor, Insulated, Lead-Covered Parkway Cable, Armored with Flat Steel or Zinc Tape—Now in Manual Part 20.
- Specification 89-50—Multiple-Conductor Insulated Cable with Weather-Resistant or Flame-Retarding Moisture-Resistant Braid Covering—Now in Manual Part 25.
- Specification 90-50—Multiple-Conductor Insulated Submarine Cable, Lead Sheathed and Round Steel Armored—Now in Manual Part 26.
- Specification 91-50—Single and Multiple-Conductor Insulated Lead Sheathed Cable—Now in Manual Part 28.
- Specification 161-50—Single and Multiple-Conductor, Insulated, Non-Metallic Sheathed Cable—Now in Manual Part 36.
- Specification 111-50—Single-Conductor Insulated Wire and Cable with Flame-Retarding, Moisture-Resistant or Weather-Resistant Braid Covering or Outer Polychloroprene Sheath—Now in Manual Part 186.
- Specification 239-50—Polychloroprene Compound Sheath for Insulated Wire and Cable—Now in Manual Part 248.
- Specification 240-50—Single and Multiple-Conductor, Insulated, Polychloroprene Compound Sheathed Cable—Now in Manual Part 249.

INVESTIGATION ON DIFFICULTIES EXPERIENCED WITH
SIGNAL SECTION SPECIFICATIONS PARKWAY TYPE
TRACK WIRE PROTECTIVE COVERINGS

For the purpose of developing information on assignment 5, Inquiry SS-95A, dated November 30, 1950, was sent to Voting Representatives of 149 Member Roads in the Signal Section. Replies were received from 68 roads, tabulated as follows:

- 22 roads were unable to furnish the information requested
- 19 roads reported no failures from the causes listed
- 7 roads advised they did not use Signal Section specifications cable
- 20 roads reported 41 cable failures resulted from improper installation,
120 from roadway equipment and tools, 135 from roadway stresses
and 82 from corrosion.

Sixty-four per cent of the cable failures attributed to roadway stresses occurred to conductors having free stripping insulation. Most of the failures occurred in stone ballasted territory where no special material like sand or clay was placed around or over the cables.

Due to the many and varied conditions present in underground cable construction, there appears to be no single type of manufactured cable that will meet all the conditions encountered such as compression and tension of conductor due to roadway stresses, frost action, or improper installation. Many failures in underground cable may be averted by proper supervision at the time cable is installed to insure that adequate slack is provided and the conductors surrounded by a wall of sand, loam, clay, or covered by a plank of wood or plastic material.

Underground cable manufactured in accordance with A.A.R. Signal Section Specifications 145-50 and 161-50 is finished with an outer covering of impregnated sisal or jute braid. This acts as a cushion or mat and provides much greater resistance to compression and tension of roadway stresses. There are other types of cable construction that may reduce failures, such as a fibre glass braid installed between the insulation and outer covering or a braid included in the insulation and outer covering. The use of stranded conductors with the two latter types of cable may also prove beneficial.

Action Recommended

Acceptance as information.

INVESTIGATION ON EXTENT OF FAILURES IN SIGNAL
SECTION SPECIFICATIONS UNDERGROUND CABLES
ATTRIBUTED TO DAMAGE CAUSED BY RODENTS,
MICRO-ORGANISMS OR TERMITES

For the purpose of developing information on assignment 6, Inquiry SS-94A, dated November 30, 1950, was sent to Voting Representatives of 149 Member Roads. Replies were received from 70 roads, tabulated as follows:

- 23 roads were unable to furnish the information requested
- 28 roads reported no failures from the causes listed
- 7 roads advised they did not use Signal Section specifications cable
- 12 roads reported 75 cable failures caused by rodents and 26 cable failures caused by termites. No failures were attributed to micro-organisms.

Most of the cables attacked were installed with a protective wall of sand or clay. There were no Signal Section specifications underground cable reported immune from the attacks of rodents.

The roads reporting cable failures attributed to termites were almost unanimous in the belief that such failures could be prevented by the use of a metallic tape, preferably non-ferrous, applied between the insulation and outer covering of underground cable. One road reported 20 years experience with underground cable of such construction without a failure from the causes listed in the inquiry.

The use of a bronze tape is to be preferred because of its resistance to corrosive action. Since there are recorded instances of rodents gnawing through steel conduit, there appears to be no complete insurance against attacks from this source. However, bronze or stainless steel tapes with a slightly greater thickness than those normally employed may serve as a deterrent.

Action Recommended

Acceptance as information.

COMMITTEE X—SIGNALING PRACTICE

Personnel

G. K. Thomas, Chairman

W. G. Salmonson, Vice-Chairman

J. A. Beoddy

C. M. Bishop

J. J. Corcoran

E. N. Fox

H. B. Garrett

W. N. Hartman

T. W. Hays

S. W. Law

H. G. Morgan

S. E. Noble

W. S. Storms

C. H. Tillett

L. C. Walters

J. S. Webb

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on noteworthy changes in signal practices.
4. Recommend uniform signal practice in the use of aspects and indications for railway signaling.
5. Recommend methods of controlling signals in single-track automatic block signal territory.
6. Investigate and report on new and improved signal devices and related appliances.
7. Investigate and report on light out protection.
8. Investigate and report as to what practical extent existing facilities and equipment can be used for related services.
9. Investigate and report on the use of automatic recording devices for checking the operation of wayside signal equipment and train movements.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Requisites for Protection for Spring Switches, Manual Part 10.
- Revision of Requisites for Automatic Block Signaling Systems, Manual Part 87.
- Revision of Requisites for Take or Leave Siding Indicator, Manual Part 71.
- Revision of Requisites for Interlocking, Manual Part 94.
5. Methods of controlling signals in single-track, automatic block signal territory.
6. New and improved signal devices and related appliances.
9. Use of automatic recording devices for checking the operation of wayside signal equipment and train movements.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

(Revision of Requisites for Protection for Spring Switches)
A.A.R. SIGNAL SECTION REQUISITES.

PROTECTION FOR SPRING SWITCHES

1951

1. *Purpose.*

(a) These requisites are for the purpose of setting forth the recommended general requirements for protection for spring switches.

2. *Spring switch.*

(a) Spring switch shall consist of spring, buffer and reinforced pair of switch points. The buffer spring shall compress, when the normally closed switch point is forced open by train trailing through it, and cause the switch point to return to its normal position after the train movement is completed, the buffer cushioning the shock.

3. *Mechanism.*

(a) Mechanism may be of the locked or non-locked type.

4. *Marker.*

(a) Marker to indicate spring switch shall be provided and may be mounted on switch stand, or on separate post at spring switch location, and at right angles to the track so that it may be seen from train approaching from the frog end. The marker shall conform to Drawing 1613.

5. *Signal protection.*

(a) Signal protection shall be provided for facing and trailing movements through spring switch within interlocking limits and through spring switch hereafter installed in automatic block signal, train stop, train control, or cab signal territory where train movements over the switch are made at a speed exceeding 20 miles per hour, except that signal protection shall be required only with the current of traffic on track signaled for movement in only one direction.

(b) The control circuits of signals governing facing movements over a main track spring switch shall be selected through the contacts of a switch circuit controller, or through the contacts of relay repeating the position of such circuit controller, which, when normally closed switch point is open $\frac{1}{4}$ in. or more, will cause such signals to display their most restrictive aspects, except that where a separate aspect is displayed for facing movements over the switch in the reverse position the signal shall display its most restrictive aspect when the switch points are open $\frac{1}{4}$ in. or more from either the normal or reverse position.

(c) The indication of signal governing movements from siding to main track with the current of traffic on track signaled for movements in only one direction through a spring switch in automatic block signal territory shall be not less restrictive than Proceed at Restricted Speed, when the block, into which movements are governed by the signal, is occupied, and shall be Stop when the main

5. *Signal protection.*—Continued.

track is occupied by a train approaching the switch within at least 1,500 ft. in approach of the approach signal located stopping distance from the main track signal governing trailing movements over switch, except that the indication may be caused to be less restrictive if approach or time locking is used.

(d) The indication of signal governing movements against the current of traffic from the reverse main of main tracks to a single track, or signal governing movements from a siding to a main track signaled for movements in either direction, through a spring switch, in automatic block signal territory, shall be not less restrictive than Proceed at Restricted Speed when the block, into which movements are governed by the signal, is occupied by a preceding train, and shall be Stop when the block on the single track into which the signal governs is occupied by an opposing train.

(e) The indication of signal governing movements against the current of traffic from the reverse main of main tracks to a single track or signal governing movements from a siding to a main track signaled for movements in either direction through a spring switch in automatic block signal territory shall be Stop when the normal direction main track of two tracks or the single track signaled for movements in both directions is occupied by a train approaching the switch within at least 1,500 ft. in approach of the approach signal located stopping distance from the main track signal governing trailing movements over switch, except that indication may be caused to be less restrictive if approach or time locking is used.

(f) On spring switches in main tracks located in other than interlocking limits or automatic block signal territory where train movements over the switch are made at a speed exceeding 20 miles per hour, facing point protection shall be provided.

6. *Speed restrictions.*

(a) Speed restrictions shall be provided for trailing movements when springing the points.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for Protection for Spring Switches,
Manual Part 10.

(Revision of Requisites for Automatic Block Signaling Systems)
A.A.R. SIGNAL SECTION REQUISITES.

AUTOMATIC BLOCK SIGNALING SYSTEMS

1951

1. These requisites are for the purpose of setting forth the recommended general requirements for automatic block signaling systems.

2. All control circuits, the functioning of which affects safety of train operation, shall be designed on the closed circuit principle, except circuits for roadway equipment of intermittent automatic train stop system.

3. Each roadway signal shall be located over or to the right of the track it governs.

4. Aspects shall be shown by the position of semaphore blades, color of lights, position of lights, flashing of lights, or any combination thereof. They may be qualified by marker plate, number plate, letter plate, marker light, shape and color of semaphore blades or any combination thereof, subject to the following conditions:

(a) Night aspects of roadway signals, except qualifying appurtenances, shall be shown by lights; day aspects by lights or semaphore arms. A single white light shall not be used.

(b) Reflector lenses or buttons or other devices which depend for visibility upon reflected light from an external source shall not be used in night aspects, except qualifying appurtenances.

(c) The fundamental indications of signal aspects shall conform to the following:

1. A red light, a series of horizontal lights, or a semaphore blade in a horizontal position shall be used to indicate Stop.

2. A yellow light, a lunar light, or a series of lights or a semaphore blade in the upper or lower quadrant at an angle of approximately 45 deg. to the vertical, shall be used to indicate that speed is to be restricted and stop may be required.

3. A green light, a series of vertical lights, or a semaphore blade in a vertical position in the upper quadrant, or 60 or 90 deg. in the lower quadrant shall be used to indicate Proceed at Authorized Speed.

5. Each roadway signal shall be located with respect to the next signal or signals in advance which govern train movements in the same direction so that the indication of a signal displaying a restrictive aspect can be complied with by means of a brake application, other than an emergency application, initiated at such signal, either by stopping at the signal where a stop is required, or by a reduction in speed to the rate prescribed by the next signal in advance where reduced speed is required.

6. The failure of a lamp in a light signal or a semaphore signal arm assuming a false restrictive position shall not cause the signal to display a more favorable indication than intended.

7. The battery or power supply for each signal control relay circuit, where an open-wire circuit or a common return circuit is used, shall be located at the end of the circuit farthest from the relay.

8. Signals shall be controlled automatically by track circuits extending through the entire block.

9. Signal governing movements over hand-operated switch in the facing direction shall display its most restrictive aspect when the normally closed point is open $\frac{1}{4}$ in. or more and, in the trailing direction, $\frac{3}{8}$ in. or more, except that where a separate aspect is displayed for facing movements over the switch in the normal and in the reverse position, the signal shall display its most restrictive aspect when the switch points are open $\frac{1}{4}$ in. or more from either the normal or reverse position.

10. At hand-operated crossover between main tracks, protection shall be provided by one of the following:

(a) An arrangement of one or more track circuits and switch circuit controllers.

(b) Facing point locks on both switches of the crossover, with both locks operated by a single lever.

(c) Electric locking of the switches of the crossover.

11. Signals governing movements over either switch of the crossover shall display their most restrictive aspect when any of the following conditions exist:

(a) Where protection is provided by one or more track circuits and switch circuit controllers, and either switch is open or the crossover is occupied by a train, engine, or car in such a manner as to foul the main track.

(b) Where facing point locks with a single lever are provided, and either switch is unlocked.

(c) Where the switches are electrically locked, before the electric locking releases.

12. On track signaled for movements in both directions, a train shall cause one or more opposing signals immediately ahead of it to display an aspect requiring a stop. On such track, signals shall be so arranged and controlled that if opposing trains can simultaneously pass signals displaying proceed aspects, and the next signal in advance of each such signal then displays an aspect requiring a stop, the distance between opposing signals requiring a stop shall be not less than the aggregate of the stopping distances for movements in each direction. Where such opposing signals are spaced stopping distance apart for movements in one direction only, signals arranged to display restrictive aspects shall be provided in approach to at least one of the signals. Where such opposing signals are spaced less than stopping distance apart for movements in one direction, signals arranged to display restrictive aspects shall be provided in approach to both such signals.

13. The circuits shall be so installed that each signal governing train movements into a block will display its most restrictive aspect when any of the following conditions obtains within the block:

(a) Occupancy by a train, engine, or car.

(b) When points of a switch are not closed in proper position.

(c) When an independently operated fouling point derail equipped with switch circuit controller is not in derailing position.

(d) When a track relay is in de-energized position, or when signal control circuit is de-energized.

14. Signal control and electric locking circuits shall not be selected through the contacts of instruments designed primarily for indicating or annunciating purposes in which an indicating element attached to the armature is arranged so that it can in itself cause improper operation of the armature.

15. Dragging equipment and slide detectors and other similar protective devices shall be arranged to operate in conjunction with the automatic block signal system.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for Automatic Block Signaling Systems,
Manual Part 87.

METHODS OF CONTROLLING SIGNALS IN SINGLE-TRACK
AUTOMATIC BLOCK SIGNAL TERRITORY

A previous report* on this subject was presented for discussion at the 1949 Annual Meeting. Two charts showing typical controls for the APB system, the overlap system, and the APB system with station overlap, accompanied the report. They were drawn to scale for purpose of comparison. The controls as shown on those charts are so arranged that proper restrictive indications are provided to protect both following and opposing movements. However, the controls shown for the overlap system are based upon the assumption that opposing signals are not spaced stopping distance apart.

The discussion brought out that the charts as prepared, drawn to scale, might be confusing to those using them as a guide in planning actual installations. Actually, the controls as shown on sheet 1 for the APB system necessitate signals at ends of sidings being spaced stopping distance apart in order to provide proper restrictive indications for both following and opposing movements, whereas with the diagram to scale it would appear these signals are not so spaced.

The Committee has given further consideration to the discussion, as a result of which the charts have been revised, eliminating the scale from both of them and adding notes A and B in order to further clarify the application of the APB system as shown in Chart 1. The revised charts as herein presented, covering typical controls for automatic block signals on single track for three systems: namely, APB, overlap, and APB with station overlap, are recommended as a guide to be followed when planning actual installations of automatic block signals on single track. Deviations from the typical arrangement may, of course, be made as desired, consistent with local conditions, such as gradient, curvature, authorized train speed, tonnage, density of traffic, location of signals, etc.

Action Recommended

Acceptance as information.

* A.A.R. Signal Section 1948 Proceedings, Vol. XLVI, pp. 374 and 497.

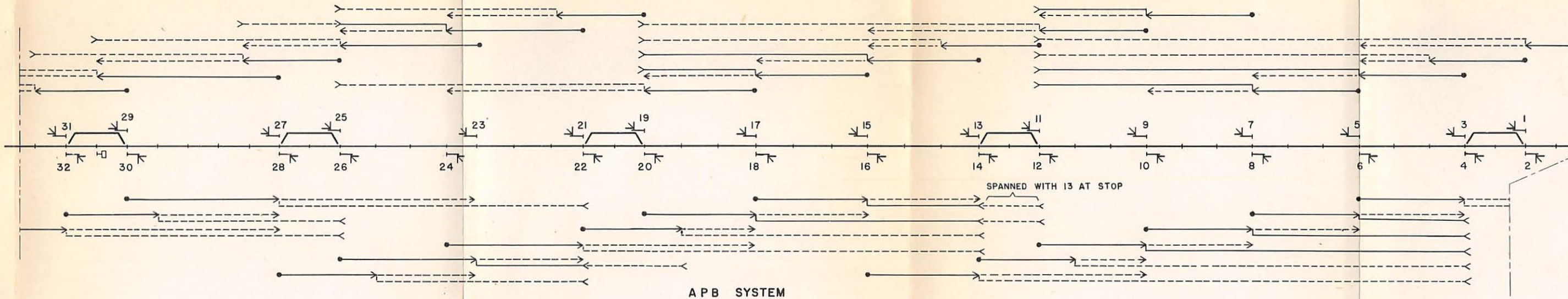
NOTES

A: APB CONTROLS ARE BASED ON SIGNALS AT SIDINGS BEING SPACED STOPPING DISTANCE APART FOR FOLLOWING MOVEMENTS.

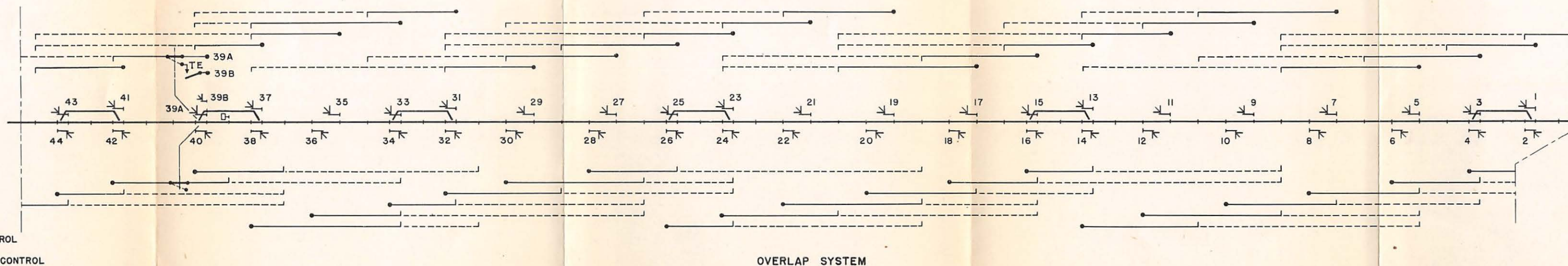
B: LEAVING SIGNALS AT SIDINGS MAY BE LOCATED AT CLEARANCE POINT OF SIDING IF DESIRED.

KEY

- STOP CONTROL
- - - APPROACH CONTROL
- ← CONTROL LIMIT, FOLLOWING
- > CONTROL LIMIT, OPPOSING
- STATION OVERLAP SIGN



- STOP CONTROL
- - - APPROACH CONTROL
- STATION OVERLAP SIGN



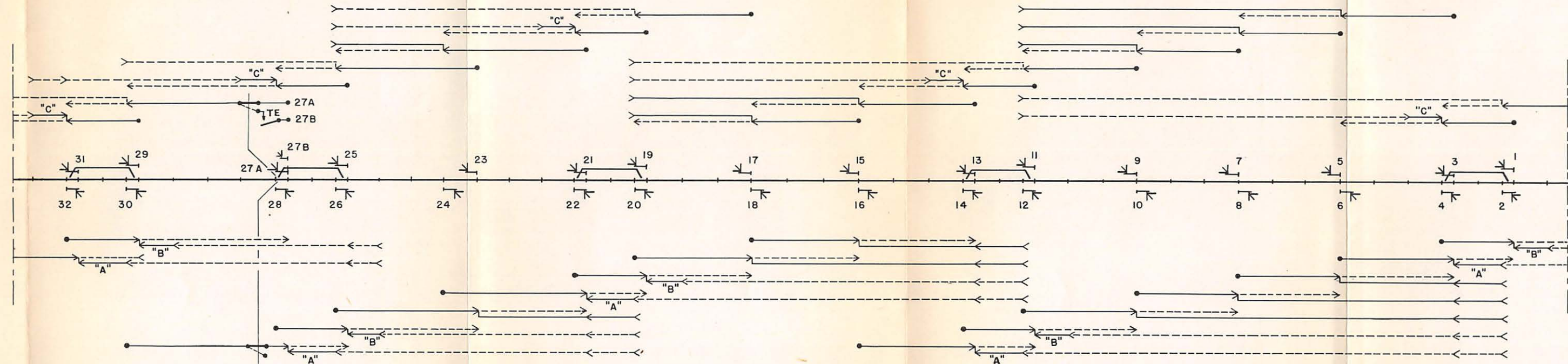
TYPICAL CONTROLS FOR AUTOMATIC BLOCK SIGNALS
ON SINGLE TRACK

NOTES

- A: STATION OVERLAPS "A" IN CONTROLS OF EASTWARD SIGNALS ARE SPANNED WHEN WESTWARD LEAVING SIGNAL INDICATES STOP.
- B: OVERLAPS "B" IN CONTROLS OF EASTWARD ENTRANCE SIGNALS ARE SPANNED WHEN WESTWARD ENTRANCE SIGNAL INDICATES STOP.
- C: OVERLAPS "C" IN CONTROLS OF WESTWARD ENTRANCE SIGNALS ARE SPANNED WHEN EASTWARD ENTRANCE SIGNAL INDICATES STOP.
- D: OPERATION OF PUSH BUTTON AT WESTWARD LEAVING SIGNALS SETS SIGNAL AT STOP PERMITTING EASTWARD SIGNALS TO CLEAR.
- E: OPERATION OF PUSH BUTTON AT ENTRANCE SIGNALS PERMITS SIGNAL TO CLEAR FOR SWITCHING MOVEMENTS

KEY

- STOP CONTROL
- - - - APPROACH CONTROL
- ← CONTROL LIMIT, FOLLOWING
- > CONTROL LIMIT, OPPOSING



APB SYSTEM WITH STATION OVERLAP

USE OF AUTOMATIC RECORDING DEVICES FOR CHECKING
THE OPERATION OF WAYSIDE SIGNAL EQUIPMENT
AND TRAIN MOVEMENTS

The following information was obtained from replies to a questionnaire (Inquiry SS-97A) which was issued January 11, 1951 to Voting Representatives of Member Roads in the Signal Section.

Ninety-six replies were received, 56 of which indicated that no such devices were in use.

The replies received from 40 railroads using such devices furnished information with respect to type, purpose for which used, and number of installations in service, as follows:

1. Automatic graphic time recorder, spring or electric drive, multiple electromagnetically operated pen type, permanently installed at automatic, remotely controlled, and manually operated interlockings.

These devices are used where it is desired to record the operation of various functions in approach to and within interlocking limits.

One hundred sixty-seven such installations were reported in service.

2. Automatic graphic time recorder similar to that described in Item 1, permanently installed at signals or other locations, the pens of which are track circuit controlled.

Seven such devices were reported in use for the purpose of indicating train speeds.

3. Automatic traingraph, multiple electromagnetically operated pen type, permanently installed on control machines.

Such devices are used for the purpose of recording OSing of trains and in some cases the operations of various other functions in traffic control territory.

Sixty-four such installations were reported in service.

4. Portable type automatic graphic time recorder, spring or electric drive, with multiple electromagnetically operated pens.

These devices are temporarily installed at signals or other locations for the purpose of recording time, frequency, and duration of operation of various functions. Reports indicate that valuable information is often obtained in determining cause of intermittent interruptions to the proper functioning of signal apparatus.

Such devices were reported in use on three railroads.

Action Recommended

Acceptance as information.

(Revision of Requisites for Take Siding Indicator and Leave Siding
Indicator for Non-Interlocked Switch)
A.A.R. SIGNAL SECTION REQUISITES.

TAKE OR LEAVE SIDING INDICATOR

1951

1. These requisites are for the purpose of setting forth the recommended general requirements for take siding indicator or leave siding indicator for non-interlocked switch.
2. The aspect shall be provided by the display of:
 - (a) The letter "S."
 - (b)
3. The aspects displayed by the take siding indicator and leave siding indicator shall be distinctive from those displayed by fixed signals.
4. It may be mounted on a separate mast, or on a signal mast located to best meet the requirements.
5. When located less than stopping distance from the switch, an Approach indication should be provided.
6. The minimum distance of visibility, under normal day and night conditions, shall be 500 ft.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded

Requisites for Take Siding Indicator and Leave Siding Indicator for
Non-Interlocked Switch, Manual Part 71.

(Revision of Requisites for Interlocking)
A.A.R. SIGNAL SECTION REQUISITES.

INTERLOCKING

1951

1. These requisites are for the purpose of setting forth the recommended general requirements for interlocking.

2. All control circuits, the functioning of which affects safety of train operation, shall be designed on the closed circuit principle, except circuits for roadway equipment of intermittent automatic train stop system.

3. Each roadway signal shall be located over or to the right of the track it governs.

4. Aspects shall be shown by the position of semaphore blades, color of lights, position of lights, flashing of lights, or any combination thereof. They may be qualified by marker plate, number plate, letter plate, marker light, shape and color of semaphore blades or any combination thereof, subject to the following conditions:

(a) Night aspects of roadway signals, except qualifying appurtenances, shall be shown by lights; day aspects by lights or semaphore arms. A single white light shall not be used.

(b) Reflector lenses or buttons, or other devices, which depend for visibility upon reflected light from an external source shall not be used in night aspects, except qualifying appurtenances.

(c) The fundamental indications of signal aspects shall conform to the following:

1. A red light, a series of horizontal lights, or a semaphore blade in a horizontal position shall be used to indicate Stop.

2. A yellow light, a lunar light, or a series of lights, or a semaphore blade in the upper or lower quadrant at an angle of approximately 45 deg. to the vertical, shall be used to indicate that speed is to be restricted and stop may be required.

3. A green light, a series of vertical lights, or a semaphore blade in a vertical position in the upper quadrant, or 60 or 90 deg. in the lower quadrant, shall be used to indicate Proceed at Authorized Speed.

5. Each roadway signal shall be located with respect to the next signal or signals in advance which govern train movements in the same direction so that the indication of a signal displaying a restrictive aspect can be complied with by means of a brake application, other than an emergency application, initiated at such signal, either by stopping at the signal where a stop is required, or by a reduction in speed to the rate prescribed by the next signal in advance where reduced speed is required.

6. Track circuits and route locking shall be provided throughout interlocking limits.

7. The control circuit for power-operated or slotted mechanical signal governing movements at higher than restricted speed in the facing direction over switches, movable point frogs, and derails shall be selected through cir-

cuit controller operated directly by switch points or by switch locking mechanism, or through relay controlled by such circuit controller, for each facing point switch, movable point frog, and derail in the routes governed by such signal. Circuits shall be so arranged that such signal can display an aspect to proceed only when each such switch, movable point frog, and derail in the route is in proper position. Such power-operated signals hereafter installed shall be controlled in this manner through circuit controllers or switch repeating relays for all switches, movable point frogs, and derails in the routes governed by such signals.

8. Mechanical locking, or the same protection effected by means of circuits, shall be provided.

9. The control circuits for aspects with indications more favorable than Proceed at Restricted Speed shall be selected through track relays for all track circuits in the route governed or through repeating relays for such track relays. At automatic interlocking, signal control circuit shall be selected as follows:

(a) Through track relays for all track circuits in the route governed and in all conflicting routes within interlocking limits or through repeating relays for such track relays.

(b) Through signal mechanism contacts or relay contacts closed when signals for such conflicting routes display stop aspects.

(c) Through normal contacts of time releases for such conflicting routes or contacts of relays repeating the normal position of contacts of such time releases.

10. Approach or time locking shall be provided in connection with signals governing movements at higher than restricted speed.

11. Facing point lock or switch-and-lock movement shall be provided for mechanically operated switch, movable point frog, or split point derail.

12. Indication locking shall be provided for operative approach signals of the semaphore type, power-operated home signals, power-operated switches, movable point frogs, and derails, and for all approach signals, except light signals all aspects of which are controlled by coded track circuits or by double wire line circuits.

13. The failure of a lamp in a light signal or a semaphore signal arm assuming a false restrictive position shall not cause the signal to display a more favorable indication than intended.

14. Signals shall be provided to govern the train movements into and through interlocking limits.

15. Mechanical or electric locking or electric circuits shall be installed to prevent signals from displaying aspects which permit conflicting movements except that opposing signals may display an aspect indicating Proceed at Restricted Speed at the same time on a track used for switching movements only, by one train at a time.

16. At automatic interlocking, a loss of shunt for 5 seconds or less shall not permit an established route to be changed.

17. A signal shall be provided on main track to govern the approach with the current of traffic to any home signal except where the home signal is the first signal encountered when leaving yard or station and authorized speed approaching such signal is not higher than slow speed. When authorized speed between home signals on route governed is 20 miles per hour or less, an in-

operative signal displaying an aspect indicating Approach next Signal Prepared to Stop may be used to govern the approach to the home signal.

18. Signal control and electric locking circuits shall not be selected through the contacts of instruments designed primarily for indicating or annunciating purposes in which an indicating element attached to the armature is so arranged that it can in itself cause improper operation of the armature.

19. Electric lock shall be provided for each hand-operated switch or derail within interlocking limits, except where train movements are made at not exceeding 20 miles per hour. At manually operated interlocking it shall be controlled by operator of the machine and shall be unlocked only after signals governing movements over such switch or derail display aspects indicating Stop. Approach or time locking shall be provided.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisites for Interlocking, Manual Part 94.

NEW AND IMPROVED SIGNAL DEVICES
AND RELATED APPLIANCES*

It should be understood that this is solely a report to inform the members of the availability of the various devices mentioned therein, and what the manufacturers claim they will do. It is submitted as information—it does not constitute any Signal Section recommendation.

Stainless steel terminal for rail head bonds.

Extensive experiments, made for the aircraft industry, developed information which led to the fabrication and application of stainless steel for the manufacture of terminals for rail head bonds. At the present time terminals made of this material have twice the holding power and more than twice the resistance to shearing as compared to terminals made of mild steel. The terminals are corrosion-resisting, and due to the manner of fabrication they are produced more rapidly than the usual mild steel terminal.

As the resistance to shear and the added resistance against pulling out of rail is much higher than mild steel, there is less breakage due to dragging equipment, etc. This is further assisted by a decrease in the front area of terminal.

This is a development of the Hanlon & Wilson Co.

Improved megger ground tester.

A new megger ground tester, known as the CVM type, provides a dependable and easy method for ascertaining if the resistance to earth of an artificial ground is sufficiently low to minimize dangers due to lightning.

The device includes its own generator for supplying test currents, and is therefore always ready for service without dependance upon a battery or other supply of energy. It does not require any calculations, adjusting, or balancing, and is unaffected by stray earth currents, either a.c. or d.c. It is smaller, lighter and less costly than the former Meg-Ground Tester. It weighs only 6 pounds and measures 5 by 5¼ by 7½ inches, having scale ranges of zero to 40 and zero to 200; zero to 100 and zero to 500 ohms.

This is a development of the James G. Biddle Co.

Megger insulation tester.

An improved type of megger for testing and measuring insulation resistance may be used as a dual-operated hand-cranked device, or as a plug-in device.

When used as a plug-in device, a rectifier and transformer are the essential parts for supply current. They are built in as part of the equipment with the megger type ohmmeter.

When used as a dual-operated tester, it can be operated either by hand or by plug-in connection from a separate rectifier.

Among many applications to which either of the types give reliable readings, is the testing of multiple-conductor cables and power circuits in numerous locations in railway signaling installations.

* Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 249 and 341.

Megger insulation tester.—Continued.

The hand-driven generator type in the dual-operated model is suitable for field testing, especially where power is not available.

It weighs $7\frac{1}{2}$ pounds and measures 5 by $6\frac{1}{2}$ by 9 inches.

This is a development of the James G. Biddle Co.

Small megger insulation tester.

A new megger for testing insulation resistance, known as the CVM megger insulation tester, includes a hand-operated generator within the carrying case along with the necessary parts to complete the equipment. Direct current for testing is obtained from the a.c. generator by the use of a dry rectifier which is built into the set.

This tester is particularly useful for field testing; it weighs $6\frac{1}{2}$ pounds and measures 5 by $5\frac{3}{4}$ by $7\frac{1}{2}$ inches.

Batteries or other sources of energy are not necessary.

While the range of readings is not as high as those of the larger type of megger, the CVM should be considered as a supplemental type, where size, weight, and cost are the primary factors. The range of readings is sufficiently high for most purposes in railway signal testing, indicating readings up to 50 megohms at 500 volts d.c.

This is a development of the James G. Biddle Co.

Twindriver for applying rail head bonds.

There is available a device, known as the Twindriver, which positions the rail head bond more accurately than when driven by hand. It is powered by a 1.1 h.p. gas engine at rated speed of 2,000 r.p.m., and is attached to a radial hydraulic pump producing 10,000 p.s.i. The maximum fluid pressure is 5,400 p.s.i., automatically controlled by a relief valve. The ram which drives the bond terminals produces a pressure of 12,000 pounds simultaneously on each bond terminal on A.A.R. standard centers of $4\frac{1}{8}$ inches.

The oil used in the hydraulic system is No. 10 or 10-W, S.A.E. engine oil.

Weight of complete machine is 165 pounds.

The chassis is supported by two double-flanged wheels resting on the rail to be bonded and one wheel on the opposite rail.

A latched clearance position is provided for passing special track work, road crossings, station platforms, etc.

It requires only 10 seconds to drive the two terminals.

The device is adjustable for full vertical position of holes.

This is a development of the Ohio Brass Co.

Action Recommended

Acceptance as information.

COMMITTEE XI—ELECTRONICS

Personnel

A. B. Armistead, Chairman

J. I. Kirsch, Vice-Chairman

E. F. Brown

J. E. Hillig

P. B. Burley

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A. J. Hendry

T. B. Thompson

J. M. Hesser

A. V. Dasburg*

C. B. Shields*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Investigate and report on the use of electronic controls for railway signaling.
4. Report on electronic measuring apparatus applicable to railway signaling.
5. Principles of vacuum tubes, carrier systems and other electronic systems and devices.
6. Recommend basic design principles for electronic controls for railway signaling systems.
7. Investigate and report on the effects to both signal controls and communication when superimposing centralized traffic control circuits on existing dispatchers or other communication circuits, collaborating with Communications Section, A.A.R.
8. Electronic tubes for use in signal apparatus, recommendation to cover type and designations of tubes to meet various requirements.
9. Investigate and report on the practicability of using frequencies above 30 k.c. for carrier circuits used in centralized traffic control.
10. Investigate and report on the use of electronic switches in lieu of electromagnetic relays.
11. Instructions for shop and field testing of electronic equipment used in railway signaling.

The Committee submits for consideration, reports on the following subjects**:

3. Carrier control repeater.
Broad band-narrow band carrier.
Panel-mounted carrier equipment.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

4. Electronic measuring apparatus applicable to railway signaling.
5. Carrier systems as applied to railway signaling.
6. Design principles for electronic devices used in conjunction with railway signaling systems.
7. Mutual interference between centralized traffic control and communication circuits.
8. Electronic tubes for use in signal apparatus—progress report.
9. Use of carrier frequencies above 30 kilocycles for traffic control purposes.

Disposition of 1950 Letter Ballot Subject

The following subject presented by Committee XI at the 1950 Annual Meeting was submitted to letter ballot and officially approved:

Requisites for Electronic Devices and Components—Now in Manual Part 275.

DESIGN PRINCIPLES FOR ELECTRONIC DEVICES USED IN CONJUNCTION WITH RAILWAY SIGNALING SYSTEMS

In view of the increasing use of electronic devices in railway signaling, the purpose of this report is to point out the precautions which should be taken in the selection and design of such equipment.

To provide the maximum in safety and reliability, the electronic devices used in conjunction with railway signaling systems should be designed in accordance with Requisites for Electronic Devices and Components, Manual Part 275.

In non-vital circuits, where safety of train operation is not involved, there are certain design principles which should be followed to provide for maximum reliability. These principles are as follows:

1. Circuits should be designed and components chosen to provide maximum stability with respect to temperature, vibration, control settings and voltage variations.
2. The circuit system should be so designed that maximum immunity from interfering conditions will be obtained.

In vital circuits, where safety of train operation is involved, it is imperative that no unsafe condition will result from any failure of the electronic equipment system. The circuits should be designed and the components chosen so that the following conditions shall not cause the signal to display a more favorable indication than intended:

1. Failure of any element in an electron tube.
2. Vibration of the tube elements.
3. Failure of any of the components in the electronic devices of a permanent or intermittent nature.
4. Variations in temperature, control settings or voltage (including loss of power).
5. Interference from possible external sources.

Action Recommended

Acceptance as information.

MUTUAL INTERFERENCE BETWEEN CENTRALIZED TRAFFIC CONTROL AND COMMUNICATION CIRCUITS

Questionnaire (Inquiry SS-96A) was sent to Voting Representatives of Member Roads in the Signal Section on January 5, 1951, for the purpose of obtaining information covering mutual interference between centralized traffic control and communication circuits.

A summary of the replies received from 95 railroads is as follows:

Types of centralized traffic control and communication circuit combinations	None in service	Number of railroads reporting		
		No interference (Note 1)	In service—Negligible interference (Note 2)	Appreciable interference (Note 3)
1. Direct current C.T.C. code and voice-frequency communication on same pair.....	75	10	9	1
2. Direct current C.T.C. code and carrier communication on same pair.....	85	9	1	0
3. Carrier C.T.C. code and voice-frequency communication on same pair.....	83	8	4	0
4. Carrier C.T.C. code and carrier communication on same pair.....	90	4	0	1
5. Direct current C.T.C. code on one pair and voice-frequency communication on nearby pair.....	68	26	1	0
6. Direct current C.T.C. code on one pair and carrier communication on nearby pair.....	74	21	0	0
7. Carrier C.T.C. code on one pair and voice-frequency communication on nearby pair.....	81	13	1	0
8. Carrier C.T.C. code on one pair and carrier communication on nearby pair.....	84	10	1	0
9. Any combination of signal and communication circuits not covered by the foregoing, including simplex, composite, selector operation, etc.—explain and indicate degree of interference.....	91	3	1	0

Note 1.—Interference of each circuit with the other is low enough to be considered non-existent for all practical purposes.

Note 2.—Interference is definitely detectable but is of low enough value that the resulting circuits are considered entirely satisfactory.

Note 3.—Interference is high enough to make further engineering desirable, even though the circuits are considered workable.

One railroad made the following comment on Question 1. The principal difficulty with direct current centralized traffic control code and voice-frequency communication on same pair arose from centralized traffic control codes operating selectors on dispatchers' phone circuit where inductive ringing was employed. This was overcome by going to direct ringing but in so doing it was necessary to sacrifice the simplex of the circuit.

Four railroads reported having combinations listed in Question 9.

One railroad reported carrier centralized traffic control code on one pair, with simplex printer circuit, with nearby voice and carrier frequency circuits. No interference.

One railroad reported two individual circuits on Morse telegraph. Negligible interference.

One railroad reported simplex centralized traffic control and separate telephone circuits. No interference.

One railroad reported carrier centralized traffic control code on phantom of one communication pair carrying voice-frequency and another pair carrying voice-frequency and carrier frequency (W.E. Type C). No interference.

Replies received from 95 railroads indicated that 67 per cent had no combinations of centralized traffic control code and communication circuits in service on same line. The 33 per cent which had one or more combinations in service experienced negligible or no interference between centralized traffic control code and communication circuits.

Action Recommended

Acceptance as information.

CARRIER CONTROL REPEATER

A single-channel, narrow-band repeater unit for carrier control service has been developed. It is designed for shelf-mounting, weighs 8 pounds and has external dimensions of $9\frac{1}{8}$ inches high, 7 inches wide and $8\frac{7}{8}$ inches deep.

The repeater unit is used where line wire attenuation is severe because of weather conditions, heavy loading of the line due to other facilities, or where cable or small size line wire must be employed between the transmitter and receiver.

The unit consists of a U-shaped chassis bearing on its front panel the metering jack entrances, output control, fuse receptacles and off-and-on toggle switch. All external connections are made by means of A.A.R. standard tagged terminal posts at the top rear. There are two covers acting as coil compartments—one at the top and a U-shaped one at the bottom.

In installing the unit, the only precaution to be observed is that it will not be subjected to the effects of rain, sleet or snow. It may be installed in either a heated or unheated housing.

Repeater Data

Power consumption.....	20 watts
Heaters at 26 volts a.c. or d.c.....	0.74 ampere
Plates at 26 volts d.c.....	0.040 ampere
Nominal input and output impedances.....	650 ohms
Output level into 600 ohms.....	+ 16 dbm, max.
Input level.....	- 12 dbm, min.
Frequency range.....	10-30 KC
Control tube.....	26A6
Voltage amplifier tube.....	26A6
Power amplifier tube.....	26A7GT

The repeater unit is a combination transmitter and receiver. It consists essentially of a control stage, a voltage amplifier and a power amplifier. It is designed to accept one particular frequency and be unresponsive to others.

The function of the control stage is to regulate automatically the value of the signal before it is applied to the voltage amplifier.

Referring to Fig. 1, a carrier signal of the correct frequency enters the repeater unit at terminals L1N and L2N and is passed on to resistors R4 and R5 by means of the coupled resonant circuit comprised of coil T1 and capacitors C1 and C2, and of coil T2 and capacitor C3.

Resistors R4 and R5 act as a voltage divider. The voltage impressed across R5 is maintained essentially constant by the action of the control tube V1. Through resistors R13 and R14, the grid bias on V1 is kept negative and is so set that the tube is practically cut off with a weak signal present. Therefore, with a low value of signal the voltage across R4 and R5 is not affected by tube V1 and the first stage operates at full sensitivity.

With rising signal levels, the voltage across rectifier D1 increases. This causes the rectified d.c. voltage across D1 to increase. The polarity is such that the grid bias of V1 is made less and less negative as the signal increases. The reduction of this bias causes a reduction in the plate resistance of the tube. Since the plate circuit is in parallel with resistor R5 and both are in series with voltage dropping resistor R4, the signal voltage across R5 is prevented from rising, and thus the voltage impressed across resistor R6 is maintained substantially constant.

Resistor R3 and capacitor C5 serve as a coupling network to the rectifier D1 and are of relatively high impedance in order not to become a load on coil T2.

Resistor R1 and capacitor C4 together form a filter which maintains the junction of coil T2 and resistor R5 at the common a.c. ground. Capacitor C6 prevents any a.c. from appearing on the grid of tube V1, and in conjunction with resistor R2 forms a long time-constant circuit to maintain the grid bias during interruption of the carrier signal due to coding. Metering jack J1 is provided to determine the condition of tube V1 and rectifier D1 and is also used to adjust the bias of tube V1.

The a.c. input to the voltage amplifier stage is determined by the adjustment of the potentiometer R6. This is the gain control used to set the output voltage of the repeater. Since the voltage across R6 is maintained substantially constant by the action of tube V1 the output of the repeater is held substantially constant over wide variations in input signal level.

C7 and C8 are coupling capacitors that also serve to isolate the d.c. plate voltages from the grids of the following amplifier tubes. Cathode resistor R7

Item	Description
C1	Depends on frequency
C2	Depends on frequency
C3	Depends on frequency
C4	0.047 mfd., 400 vdcw.
C5	0.005 mfd., 500 vdcw.
C6	1.0 mfd., 600 vdcw.
C7	0.005 mfd., 500 vdcw.
C8	0.005 mfd., 500 vdcw.
C9	1.0 mfd., 600 vdcw.
C10	0.5 - 0.5 mfd., 600 vdcw.
C11	Depends on frequency
C12	Depends on frequency
C13	Depends on frequency
D1	Germanium crystal rectifier
F1	2 amp.
F2	2 amp.
R1	1000 ohms, 1/2 watt
R2	1.0 megohm, 1/2 watt
R3	100,000 ohms, 1/2 watt
R4	82,000 ohms, 1/2 watt
R5	68,000 ohms, 1/2 watt
R6	250,000 ohms, 2 watts
R7	180 ohms, 1/2 watt
R8	6,800 ohms, 1/2 watt
R9	470 ohms, 1/2 watt
R10	470 ohms, 1/2 watt
R11	47,000 ohms, 1/2 watt
R12	100 ohms, 1 watt
R13	8,200 ohms, 1/2 watt
R14	2,000 ohms, 2 watts
T1	Depends on frequency
T2	Depends on frequency
T3	Depends on frequency
T4	Depends on frequency
V1	Remote cutoff pentode, Type 26A6
V2	Remote cutoff pentode, Type 26A6
V3	Beam power amplifier, Type 26A7GT

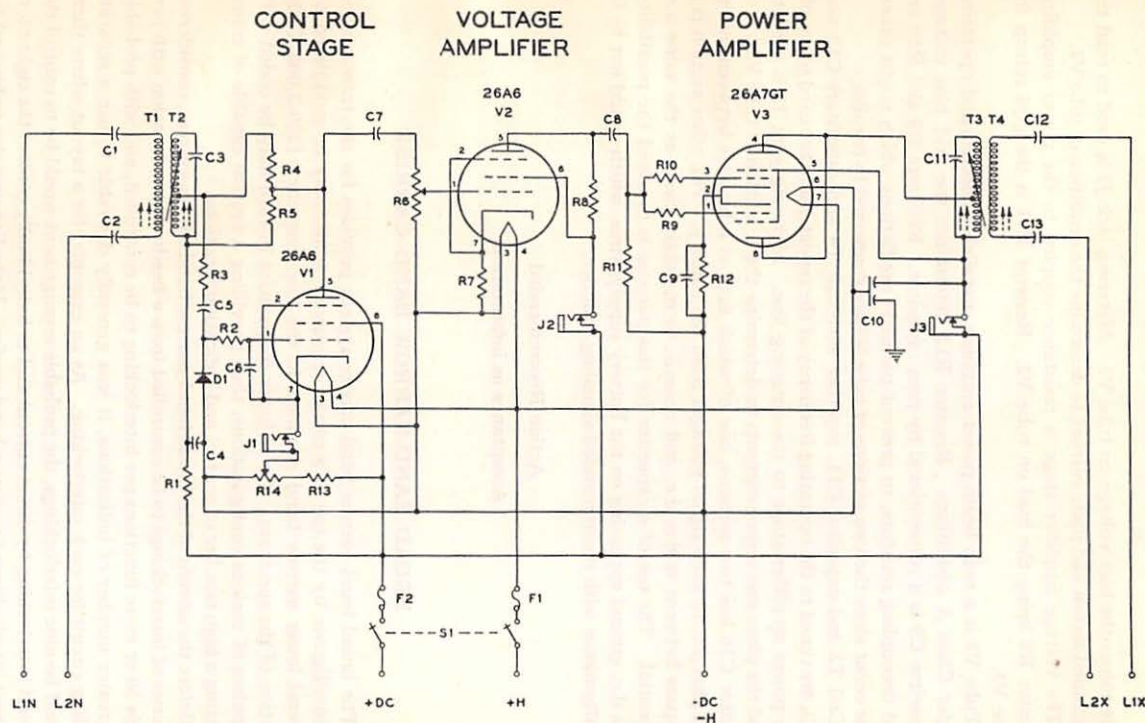


Fig. 1.

determines the bias voltage on tube V2. Metering jack J2 is used to read the combined screen and plate current to determine the condition of tube V2.

The voltage amplifier stage is resistance coupled to the power amplifier, resistor R8 being the load on tube V2. Resistor R11 is the grid return for tube V3.

Tube V3 is a twin beam power amplifier, parallel-connected and operating under Class A conditions. Resistor R12 determines the grid bias voltage; capacitor C9 is a conventional by-pass capacitor. Resistors R9 and R10 are grid decoupling resistors, to prevent parasitic oscillations which might otherwise occur since the two sections of tube V3 are connected in parallel.

Coil T3 and capacitor C11, together with coil T4 and capacitors C12 and C13, are tuned to the operating frequency of the repeater and are used to couple the power amplifier stage to the outgoing line. Metering jack J3 is used to read the plate and screen currents to determine the condition of tube V3. Capacitor C10 has two sections, one of which acts as a by-pass between minus and plus d.c. to keep signal voltages from the battery. The other section is a by-pass between minus d.c. and chassis, to maintain these at the same a.c. potential. The use of a capacitor for this purpose is to avoid the possibility of a d.c. ground appearing on the battery supply wires, which would not be in conformance with recommended signaling practice.

Action Recommended

Acceptance as information.

BROAD BAND-NARROW BAND CARRIER

The broad band-narrow band carrier system provides for the transmission of intelligence by the use of a carrier frequency which may be modulated by several lower narrow band channels in the low frequency (200-3,000 CPS) portion of the spectrum. These lower frequencies in turn may be coded with impulses of various configurations, thus providing a system capable of transmitting a high number of control and indication functions.

Before the advent of the broad band-narrow band carrier system, considering a series of interlockings to be controlled from a headquarters location with perhaps 30 or more functions per interlocking to be controlled, and with probably a greater number of indications, it was generally desirable to use a separate coding circuit for each interlocking. As an example: for a layout where there would be nine interlockings, the probable arrangement would be to control the closest interlocking by direct current and to individually control the eight more distant interlockings by narrow band carrier. If the line was also to be used for voice transmission, it would be necessary to use the range of frequencies for the narrow band carriers above the voice range for the control and indication frequencies. With eight interlockings to be remotely controlled with the conventional narrow band coded carrier circuits, a total of 16 frequencies would be required. In the 7-30 KC frequency range which is generally used for this service and which is above voice range, the A.A.R. practice is to transmit frequencies between 7 and 17 KC westward or southward and the frequencies between 17 and 30 KC eastward or northward. It is generally considered im-

practical to operate 16 narrow band carrier frequencies in this range without mutual interference because of the cost in providing and difficulty of maintaining filters having the desired selectivity characteristics. Further, the equipment required for the repeater stations for the more distant interlockings would be so complex as to be impractical. This is also one of the chief reasons why the frequency spectrum above 30 KC is not used to obtain 16 narrow band channels. The use of these frequencies in this range also eliminates the possibility of using either C or H carrier on the same metallic circuit and would probably require transpositions for 30 KC where a C system is in close proximity.

A practical and satisfactory solution to this problem of controlling a multiplicity of interlockings is found in the installation of the broad band-narrow band carrier system which effectively and economically makes use of the available frequency spectrum. In this system, one broad band carrier frequency is used for control and a second for indication for the entire series of interlockings. Eight narrow band frequencies in the low range are used to modulate the control broad band carrier, one frequency associated with each interlocking. Similarly, the indication broad band carrier is modulated by eight narrow band frequencies, each frequency being associated with its particular interlocking. Since the control and indication broad band carriers are separated in the frequency spectrum, it is practicable to use the same eight frequencies for modulating each of these carriers without interference. Likewise, since the eight channels in the low portion of the frequency spectrum enter the broad band carrier circuits only, they do not interfere with the physical voice circuit on the same line pair. These lower frequencies are coded to provide the control and indications for the interlockings. By the introduction of the broad band carrier circuits, the number of narrow band channels for coding has been reduced from 16 to 8 and allows for placing the over-all carrier circuits in the frequency spectrum outside of that portion used for other services. It is a comparatively easy proposition to segregate the low range into the eight required channels.

The broad band control and indication frequencies are usually higher than those used for C and H carrier, thereby permitting the use of these carriers on the same line pair or adjacent line pairs without need for retransposing. Where the installation is quite extensive, requiring a greater number of channels than can be handled by one pair of broad band frequencies, the same low frequency channels may again be used to modulate a second pair of broad band frequencies.

The outstanding advantage of the broad band-narrow band carrier system is that the limits of the frequency spectrum required for the narrow band channels are much narrower than would ordinarily be required for the control of an extensive consolidation of remote interlockings, thereby making it practical and economical to operate such a consolidation without interfering with other facilities on the same line circuit. Another important advantage is that the repeater stations are greatly simplified because only one repeater is required for each broad band carrier frequency.

Action Recommended

Acceptance as information.

PANEL-MOUNTED CARRIER EQUIPMENT

Carrier equipment, narrow band, broad band, and broad band-narrow band, is now available panel-mounted. The panels are arranged for assembly on standard communication equipment racks, small racks suitable for locating on shelves, or in cases.

The narrow band coded carrier employs a single carrier frequency which is interrupted or coded to transmit intelligence.

The broad band carrier consists of a single carrier frequency plus the upper and lower side bands approximately 3,000 cycles wide produced by modulating the single carrier with speech. The unmodulated carrier and both side bands are transmitted over the line. For full duplex communication, two broad band carriers are used, one in each direction separated in the frequency spectrum.

The broad band-narrow band carrier consists of a single carrier modulated by a number of individual frequencies in the low range (200-3,000 CPS) instead of by speech. The broad band-narrow band system conserves the frequency spectrum where it is necessary to provide for the control of a large number of functions at each of a number of remotely controlled locations.

The narrow band carrier equipment is available in two types, one of which operates between 4 and 30 KC and the other between 0.2 and 6 KC. Either type of narrow band equipment may be used for direct coupling to the line. The low frequency type of equipment when operated between 0.2 and 3 KC may also be used to modulate the broad band carrier equipment. The broad band, or broad band-narrow band equipment is applicable for operation in the 32 KC to 78 KC frequency spectrum.

This new design has a number of advantages. First, it allows much greater flexibility in handling various circuit components such as the power pack, oscillators, amplifiers and relay filter assemblies. Second, it coordinates with equipment now in use for communication purposes. The panel-mounted equipment was designed to reduce the items necessary for the various types of services, and to coordinate the code control and communication equipment. This facilitates maintenance and handling of parts and also reduces the number of spare parts required.

The general grouping of equipment is as follows:

Terminals	Repeaters
1. Relay and filter panels	1. Filter panels
2. Receiving panels	2. Amplifier panels (eastward-northward)
3. Transmitting panels	3. Amplifier panels (westward-southward)
4. Power supply panels	4. Power supply panels

The equipment is adaptable to three types of assembly:

1. Standard communication equipment racks.

Particularly adaptable to office locations involving several units or where sufficient rack space is already available.

2. Individual racks.

Each rack will hold four panels as listed in the foregoing tabulation; that is, one rack is needed for each unit. It is readily adaptable for shelf mounting in the field and has the plug-in components facing the front for ease of maintenance.

3. Individual case mounting.

Individual case mounting is used for centralized traffic control equipment only. Panels 2, 3 and 4 are arranged for rack mounting inside the case. The relay and filter equipment is mounted on the top of the case and is plug-coupled.

In all the types of mounting for signal service, external wiring connections are made to a terminal board. The connections to each panel are made by means of a plug connector.

One unit will usually consist of four panels as previously indicated. When these are mounted on a standard 19-inch communication equipment rack, a unit will require a vertical space of $17\frac{1}{2}$ inches.

In the case-mounted equipment, the housing space required is $17\frac{1}{2}$ inches wide by $9\frac{1}{2}$ inches deep by 18 inches high, which will provide room for removal of the plug-in equipment.

The individual rack will hold one each of the four panels and is $17\frac{1}{2}$ inches wide by $9\frac{1}{2}$ inches deep by $18\frac{1}{2}$ inches high. This rack can be mounted in the same shelf space as the case.

For standard rack mounting, there is available a carrier change-over panel which contains two relays for transferring units from normal to stand-by service. This panel requires $5\frac{1}{4}$ inches vertical space on the rack.

Action Recommended

Acceptance as information.

ELECTRONIC MEASURING APPARATUS APPLICABLE TO RAILWAY SIGNALING*

An electronic interval timer and counter, known as a syncrograph, has been developed by the General Railway Signal Co. The primary purpose of this instrument is to measure accurately the time intervals associated with relay operation. It is also adaptable for use as a general purpose interval timer and counter.

The following measurements are typical of those that may be made on relays:

1. Time to open back contact or to close front contact, after application of energy to a relay coil.
2. Time to open front contact, or to close back contact, after removal of energy from a relay coil.
3. Transfer time of relay contacts.
4. Cumulative time during which a front or back contact is closed, as on a coding relay operating for an observed period.
5. Time interval between operation of two relays which function at different times in a stepping or coding sequence.

* Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 254 and 345.

Time intervals measured by the syncrograph are displayed as three-digit indications, with choice of three ranges: 0.0000-0.0999; 0.000-0.999, and 0.00-0.99 seconds. Readings on all ranges are accurate to plus or minus 1 per cent of the indication, plus or minus one digit in the last column. Indications are retained until the unit is manually reset, at which time the zero reading is automatically restored. Provision is made, however, for retaining the indication while resetting start and stop circuits. This permits a cumulative total to be obtained for a series of observations without the necessity for recording and adding individual readings.

The following types of input signals may be used to start and stop the timing functions of the syncrograph:

1. Closing an external circuit.
2. Opening an external circuit.
3. Application of a positive-going (+) voltage pulse of 5-volt minimum peak, 10-microsecond minimum duration.
4. Application of a negative-going (−) voltage pulse of 5-volt minimum peak, 10-microsecond minimum duration.

Separate start and stop input circuits are used in the syncrograph, with independent controls for each, so that any of the 16 possible combinations of the mentioned inputs may be used. Start and stop input circuits are so arranged that a stop signal will not be accepted unless a prior start signal has occurred, and so that a second start will not be made, after a stop, until the timer is reset. The latter characteristic does not, however, prevent the cumulative measurement of successive intervals, since a switch is provided which permits such operation.

When the opening or closing of an external circuit is used as a start or stop input signal, the current flowing through the external circuit will not exceed 300 microamperes while the circuit is closed. When positive or negative-going voltage pulses are used for start or stop signals, the input resistance of the syncrograph is 2.2 megohms.

Threshold input sensitivity to start and stop pulses may be set at 5, 15, 50 and 150 volts, with independent control of start and stop sensitivity. This provides a means of starting and stopping timing periods only when pulses of sufficient amplitude are applied, with rejection of pulses of lower level—a desirable characteristic in the presence of line noise or of amplitude coded pulses. Maximum input voltage applied to the start and stop circuits should not exceed 300 volts.

Although the circuits and components used in the syncrograph are such that the unit is stable in calibration over long periods, the design has been planned to facilitate any testing and maintenance that may be required. An external test jack is provided from which the output pulses of the pulse generator may be obtained for comparison on an oscilloscope with a reference standard. Any frequency adjustment indicated by such comparison may then be readily made, through access holes in the side of the chassis, without removing the cover. Internal checking and repair of the unit, when necessary, are expedited by the terminal board mounting of circuit components, and the provision of adequate clearances for test prods and leads.

In addition to testing relays, the syncrograph may be used for a wide variety of time interval measurements on other equipment and circuits. In fact, the

unit will measure any time interval (within its range) whose beginning and end can be associated with any of the start and stop signals previously mentioned.

The syncrograph may also be used as a direct reading pulse counter by feeding external voltage pulses into the test jack. When used in this way, the syncrograph will count random pulses of 100 microsecond or greater separation (10,000 counts per second maximum counting rate).

The general appearance and over-all dimensions of the syncrograph are shown in Fig. 1. Weight of the unit is approximately 26 pounds.

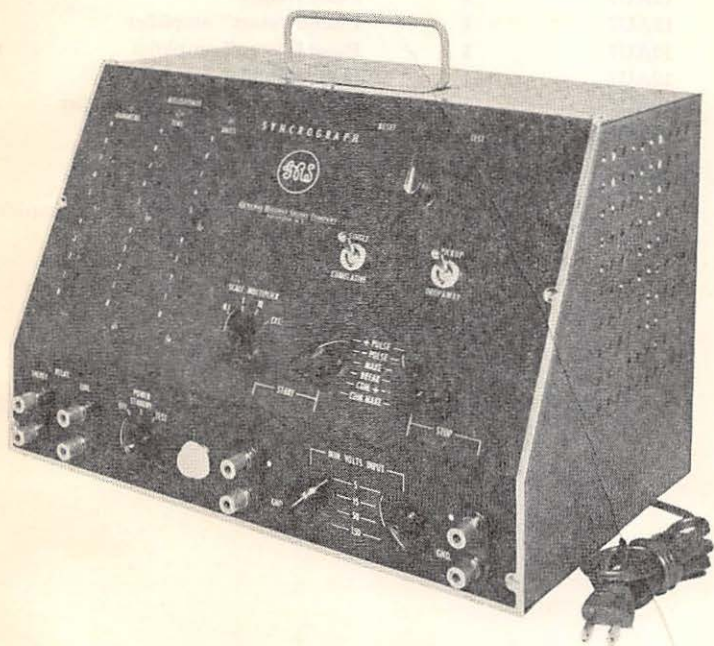


Fig. 1.

A carrying case and two 60-inch test lead assemblies are supplied for the syncrograph, with provision in the carrying case for storage of the test leads. Each test lead assembly has one end terminated in a double banana-contact plug designed for insertion in the syncrograph terminal posts. The opposite ends of the lead assemblies are terminated in banana plugs. A phone plug, four alligator clips, two phone tips and two "snapper" probes, all designed to accept banana plugs, are also supplied.

Panel terminals on the syncrograph are of the combination banana jack and binding post type. This permits the use of the plug-in test leads supplied, while at the same time facilitating the independent or simultaneous use of plain wire leads.

The syncrograph includes a built-in regulated power supply designed for operation on 105 to 130-volt, 50/60 cycle a.c., with power input requirement of approximately 140 watts.

The tube types and functions are as follows:

Type	Number used	Function
2D21	1	"Start" gate generator
2D21	1	"Stop" gate generator
6AL5	1	Gating diode and clipper
12AU7	12	Eccles-Jordan type counting circuits for decade counters
12AU7	1	Wien-bridge oscillator
12AU7	1	Pulse shaper
12AU7	1	Biased "start" amplifier
12AU7	1	Biased "stop" amplifier
12AU7	1	D.C. amplifier
12AU7	1	Gate inverter and pulse shaper
5R4GY	1	Power supply rectifier
OB2	1	Bias voltage regulator
5763	2	B+ voltage regulator
6AU6	1	B+ voltage regulator control amplifier
NE2	30	Neon indicator lamp

Action Recommended

Acceptance as information.

CARRIER SYSTEMS AS APPLIED TO RAILWAY SIGNALING

The term "carrier system" is ordinarily used to cover the assemblage of apparatus and equipment whereby multiple signal circuits are provided over a single metallic circuit. This apparatus and equipment include electron tubes as amplifiers, oscillators, modulators, demodulators and include various types of electric wave filters, the operation of which has been explained in report on Electronics as Applied to Railway Signaling presented at the 1949 Annual Meeting.*

The term "carrier" is derived from the method of transmission by which controls and indications are carried over wire by means of alternating currents of relatively high frequency, usually in the range between 200 and 75,000 cycles per second, although in some instances, frequencies both above and below these limits are in use. For example, the coded cab signal system which has been used in railway signaling for a number of years is a carrier system wherein the carrier is an alternating current, usually 60, 79 or 100 cycles per second, which is interrupted or coded at some given low rate, usually 75, 120, or 180 cycles per minute. In general, the carrier cab signal system is superimposed on the track circuit with no mutual interference between them.

It is a requisite that such a system must have means of generating, transmitting and receiving the high frequency currents which are referred to as "carriers."

Principles of generation and reception.

Alternating currents of commercial frequencies in use today are usually produced by rotating machinery, whereas the high frequency alternating currents employed in carrier systems are usually produced by oscillators using electron tubes. By using an oscillator, amplifier and filter, as shown in Fig. 1, carriers

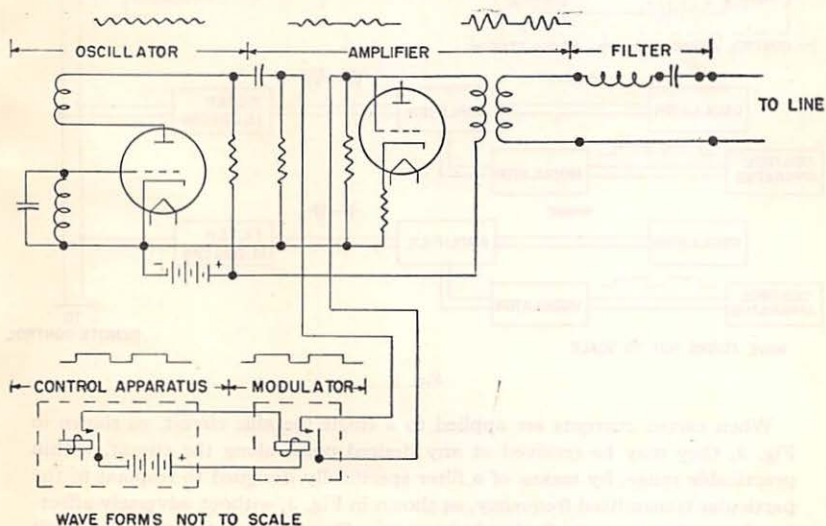


Fig. 1.

* A.A.R. Signal Section 1948 Proceedings, Vol. XLVI, pp. 385 and 500.

of desired frequency can be generated and amplified to proper magnitude. The functioning of electron tubes as oscillators and amplifiers and the functioning of filters have been explained in a previous report.

Figure 2 shows several carrier current generators each connected through its resonant filter to a line. The oscillator and filter combination of each unit is adjusted to a different predetermined frequency so that each unit will apply carrier current of the desired frequency to the line without causing mutual interference. Other similar units, adjusted for different frequencies properly selected, may also be applied to the line without adversely affecting the operation of the other generators or units, thus affording additional channels. (Adequate channel separation is accomplished by utilizing a frequency separation of approximately 10 per cent although closer spacing is frequently employed.)

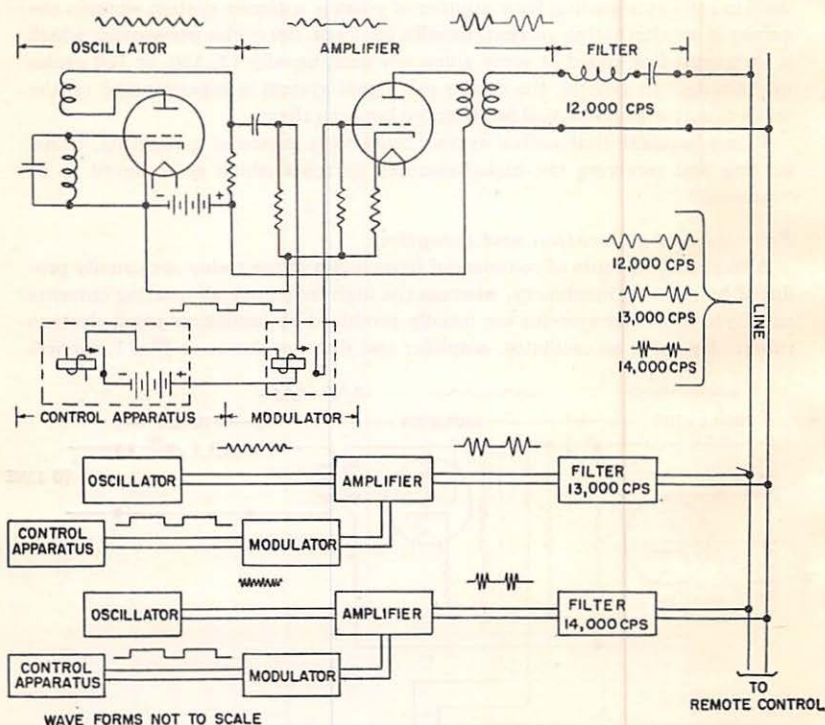


Fig. 2.

When carrier currents are applied to a single metallic circuit, as shown in Fig. 2, they may be received at any desired point along the circuit, within practicable range, by means of a filter specifically designed to respond to the particular transmitted frequency, as shown in Fig. 3, without adversely affecting the carrier currents of other frequencies. Due to loss in the metallic circuit (which is known as attenuation) it is usually necessary to amplify the received voltage so that it may be successfully utilized to operate the connected appa-

ratus. Once again the electron tube operating as an amplifier is utilized. The output of the amplifier as shown in Fig. 3 is then fed to a demodulator which detects the carrier current causing a relay to operate. The operation of a demodulator has also been described in previous report, and it is sufficient only to state that when the carrier current of the selected frequency is present the relay will be energized, but if the carrier current is not present the relay will be de-energized.

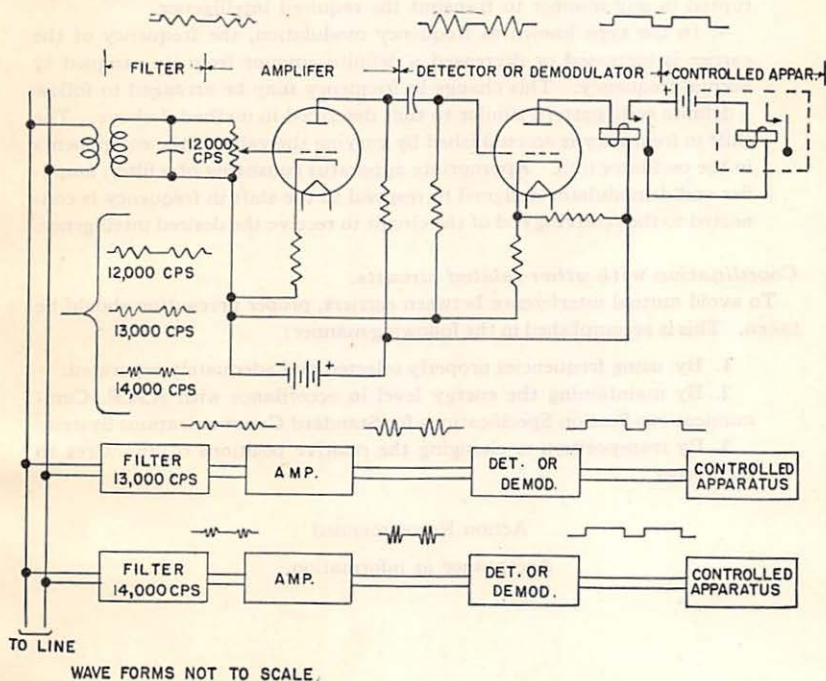


Fig. 3.

Where multiple carriers are required for additional control and indication purposes, each individual carrier may be received and utilized separately through similar apparatus as shown in Fig. 3, without responding to or adversely affecting any carrier currents of other frequencies. By utilizing apparatus of this type it is possible to control or indicate many functions over a single transmission circuit.

Carrier control.

There are several ways in which carriers may be controlled. These will be recognized as different types of modulation which have been explained heretofore. Four commonly used methods are:

1. The carrier is applied to the circuit to energize a device connected to the line and is removed to de-energize the device.
2. The carrier is stopped or interrupted at selected intervals to form a given code. Apparatus designed to respond to the given code is connected to the demodulator at the receiving end.

3. In the type called "amplitude modulation," a single low frequency, known as the signal frequency, is used to vary the amplitude of some higher frequency which is the carrier frequency. At the receiving end these variations in the amplitude of the carrier frequency are detected and reconverted to the original low frequency signal. Several low frequency signals can be transmitted simultaneously over a single carrier without mutual interference. These signal frequencies may be coded or interrupted in any manner to transmit the required intelligence.

4. In the type known as frequency modulation, the frequency of the carrier is increased or decreased a definite amount from its assigned or normal frequency. This change in frequency may be arranged to follow a definite code pattern similar to that described in method 2 above. The shift in frequency is accomplished by varying the value of the components in the oscillator unit. Appropriate apparatus consisting of a filter, amplifier and demodulator designed to respond to the shift in frequency is connected to the receiving end of the circuit to receive the desired intelligence.

Coordination with other related circuits.

To avoid mutual interference between carriers, proper precaution should be taken. This is accomplished in the following manner:

1. By using frequencies properly selected and adequately separated.
2. By maintaining the energy level in accordance with A.A.R. Communications Section Specifications for Standard Communications System.
3. By transposition or changing the relative positions of line wires to each other.

Action Recommended

Acceptance as information.

PROGRESS REPORT

ELECTRON TUBES FOR USE IN SIGNAL APPARATUS

To provide a foundation for making specific recommendations under assignment 8, it is necessary that Committee XI be completely informed as to the types of tubes being employed in railway signal equipment and the degree of satisfaction being experienced through the performance of each type. Accordingly, a survey program has been initiated and is in progress, to collect the experience of both equipment manufacturers and the railroads.

Action Recommended

Acceptance as information.

USE OF CARRIER FREQUENCIES ABOVE 30 KILOCYCLES
FOR TRAFFIC CONTROL PURPOSES*

The Richmond, Fredericksburg & Potomac R.R. has in service three interlockings, two near Milford, Va., and one at Quantico, Va., all controlled from Richmond, Va., by means of a high frequency broad band carrier which is modulated by three other lower frequencies.

At Richmond there are three single station coding units which pulse modulate low frequency transmitters of 0.84 KC, 1.24 KC and 1.58 KC. These frequencies in turn modulate a broad band carrier of 55 KC. At Doswell, which is 25 miles north of Richmond, modulated carrier is amplified through a broad band repeater. At Milford, which is 41 miles from Richmond, the carrier is demodulated, leaving only the low frequencies. There are three receivers, each responsive to one of the frequencies listed above. The receivers each control a d.c. line and in turn a single station coding unit, one coding unit at each interlocking. Two of these locations are at Milford and South Milford. The third interlocking is at Quantico, which is 38.6 miles further north.

Spare low frequency transmitters and receivers operating on 1.99 KC which can be used to replace any of the three operating units are installed at Richmond and Milford.

The indication codes are handled by the same group of low frequencies, these modulating a 75 KC broad band carrier which is also amplified at Doswell.

The larger portion of the carrier line is No. 9 copper with about 3 miles of No. 13 underground cable located between Richmond and Doswell. The connections between cable and open line wire are made through matching transformers.

The installation has operated satisfactorily since it was placed in service in January 1950.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 263 and 346.

COMMITTEE XII—CIRCUIT DESIGN

Personnel

W. W. Welsh, Chairman

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A. N. Goodson	W. M. Whitehurst
H. A. Haines	F. Youngwerth
H. L. Hinton	J. E. McMahon*
E. W. Horning	R. F. Wells*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Indexing signal literature.
2. Prepare typical circuits representing current practice for railway signaling, as follows:
 - (a) Automatic block signals.
 1. For track equipped for operation in one direction only.
 - (a) Color light type signals, conventional d.c. track circuits.
 - (b) Searchlight type signals, conventional d.c. track circuits.
 - (c) Coded track circuits with and without use of line wires.
 - (d) Electric switch locking.
 - (e) Spring switch protection.
 - (f) Approach and advance lighting.
 - (g) Light out protection.
 2. For track equipped for operation in both directions.
 - (a) Color light type signals, conventional d.c. track circuits.
 - (b) Searchlight type signals, conventional d.c. track circuits.
 - (c) Coded track circuits.
 - (d) Electric switch locking.
 - (e) Spring switch protection.
 - (f) Approach and advance lighting.
 - (g) Light out protection.
 - (b) Interlocking.
 1. Relay type interlocking, unit and route types.
 - (a) Route-check network (lever-agreement relays).
 - (b) Signal control network.
 1. Color light type signals.
 2. Searchlight type signals.
 - (c) Signal indication.
 - (d) Time locking.

* Consulting Member.

(b) *Interlocking*.—Continued.

- (e) Approach locking.
 - (f) Route locking.
 - (g) Switch locking.
 - (h) Switch control.
 - (i) Switch indication.
 - (j) Power distribution.
 - (k) Model board indications.
 - (l) Remote control circuits.
 - (m) Electric locking of hand-operated switches within interlocking limits.
 - (n) Traffic locking.
 - (o) Drawbridge protection.
2. Automatic interlocking.
- (c) Highway crossing signal protection.
- 1. Control arrangement.
 - (a) Selective speed controls.
 - (b) Interconnection with street traffic signal devices.
 - 2. Types of protection.
 - (a) Flashing lights.
 - (b) Automatic and semi-automatic gates.
- (d) Wayside typical circuits for train stop, train control, and cab signals.
- 1. Continuous.
 - 2. Intermittent.
- (e) Miscellaneous.
- 1. Power and color light train order signals.
 - 2. Lightning protection.
 - 3. OSing devices.
 - 4. Control and indication circuits using electronic devices.
3. Prepare compilation of principles of basic current design.

The Committee submits for consideration, reports on the following subjects*:

2. A.A.R. Sig. Sec. 8055A, 8056A, 8057A, 8058A, 8059A, 8060A, 8061A and 8062A.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 13, 1951.

TYPICAL CIRCUITS REPRESENTING CURRENT PRACTICE
FOR RAILWAY SIGNALING*

The Committee presents 19 typical plans covering its assignments for relay interlocking including remote control of crossover layout and local control of railroad crossing, interlocking for movable bridge where mechanical locking is used, remote control of single switch, automatic signals controlled by coded track circuits without line wires including electric switch lock location, automatic signals controlled by line wire using retained neutral-neutral relays, light out protection, and lightning protection.

The titles and explanatory notes cover the subject-matter shown on each plan. These will be supplemented at a later date by a pamphlet being prepared on the principles of basic circuit design.

While these plans represent current practice on one or more member roads, it should be understood that these typicals are not working drawings. Persons using them should be careful to take into account the type of equipment to be used and the local conditions involved.

The plans presented are:

A.A.R. SIG. SEC.

- 8055A—(Sheets 1 to 4, incl.)—Typical relay type interlocking circuits—coded remote control—functions individually controlled. Semi-automatic stick signals—restricting signals controlled through first track section only. (Assignment 2-b-1)
- 8056A—(Sheets 1 to 4, incl.)—Typical relay type interlocking circuits. Railroad crossing—local control. (Assignment 2-b-1)
- 8057A—(Sheets 1 to 3, incl.)—Typical interlocking circuits for movable bridge—using mechanical locking. (Assignment 2-b-1-o)
- 8058A—(Sheets 1 and 2)—Typical circuits remote control switch and color light signals—code control using 3 wire HD line circuits. (Assignment 2-b-1-l)
- 8059A—(Sheet 1)—Typical normally de-energized coded track circuits and traffic control without line wires. (Assignment 2-a-2-c)
(Sheet 2)—Same for electric switch lock location. (Assignment 2-a-2-d)
- 8060A—(One Sheet)—Typical four aspect color light automatic signal circuits using biased neutral D relay, retained neutral H relay and neutral slow release AD relay. (Standard Code Rules 281-282-285-291) (Assignment 2-a-1-a)
- 8061A—(Sheets 1 and 2)—Typical light out protection circuits to prevent display of less restrictive aspects, searchlight type signals. (Assignment 2-a-1-g)
- 8062A—(One Sheet)—Typical circuits for lightning protection. (Assignment 2-c-2)

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1949 Proceedings, Vol. XLVII, pp. 266 and 342.

RULES OF ORDER

Effective April 6, 1938

Revised: December 6, 1938; May 22, 1940; March 12, 1941; May 17, 1944;
December 11, 1946; June 8, 1949.

1. **REPRESENTATIVES:** The representatives of Member Roads in the Signal Section shall be employees engaged in an official or supervisory capacity in the design, construction or maintenance of railroad signaling devices. Included within this category shall be Signal Superintendents, Signal Engineers and their Assistants, Signal Inspectors, Chief Draftsmen, Signal Supervisors and Assistant Signal Supervisors, or others with corresponding duties.
2. **AFFILIATED MEMBERS:**
 - (a) **RAILROAD AFFILIATED MEMBERS:** A member of a State or Federal regulatory body, or a railroad employee not embraced within the provisions of paragraph 1 (including those temporarily relieved from service or furloughed) may become a **RAILROAD AFFILIATED MEMBER** upon approval of his application by the Committee of Direction. Such a member will pay an annual fee of \$3.00 (which may be changed from year to year at the discretion of the Committee of Direction), on January 1st of each year, for which he will receive currently the Advance Notices and Minutes of the Section.
 - (b) **AFFILIATED MEMBERS:** A representative of an organization or an individual engaged in the design, manufacture, sale or construction of signal devices or materials applicable thereto, or one who is qualified by his business relations and practical experience to cooperate with the Section, may become an **AFFILIATED MEMBER** thereof upon approval of his application by the Committee of Direction. An Affiliated Member will pay an annual fee of \$6.00 (which may be changed from year to year at the discretion of the Committee of Direction), on January 1st of each year, for which he will receive currently the Advance Notices and Minutes of the Section.
 - (c) A Railroad Affiliated or an Affiliated Member shall have the rights and privileges accorded a Member Road representative except voting or the holding of office.
 - (d) A Railroad Affiliated or an Affiliated Member may be appointed as a Consulting Member of any Standing Committee upon the approval of the Committee of Direction.
3. **LIFE MEMBERS:** Life membership may be conferred upon members who retire from active work. They shall have been active in the affairs of the Signal Section and its predecessors and their total term of membership shall have been not less than twenty-five years. Their rights and privileges shall be continued without change. A proposal to confer Life Membership must be signed by five voting representatives of Member Roads and five representatives of Member Roads, stating their reason for

making such proposal. Proposal shall be duly considered at a meeting of the Committee of Direction and then submitted to a vote by letter to the Committee of Direction membership for approval.

Officers and Committees

4. The Officers of the Section shall consist of a Chairman, First Vice-Chairman, Second Vice-Chairman, and Secretary.

(a) The Chairman and Vice-Chairmen shall be selected by the Committee of Direction on or before November 1st. Their terms of office shall be one year from January 1st or until their successors are selected and qualified. A Chairman or Vice-Chairman having served a full term shall not succeed himself.

(b) The Secretary will be appointed by the Committee of Direction. His salary shall be named by that Committee subject to the approval of the Vice-President, Operations and Maintenance Department of the Association.

(c) The COMMITTEE OF DIRECTION will consist of twelve members, as follows: The Chairman, the First Vice-Chairman, the Second Vice-Chairman, the latest Past Chairman, one member from New England or Canada, three members from the East, one member from the South and three members from the West.

The territorial representatives, except when filling vacancies, shall serve four years and their term of office will expire on December 31st of the fourth year.

Vacancies in official positions or of territorial representatives shall be filled until the next election, by the Committee of Direction.

One Vice-Chairman shall be selected from Eastern Territory and one from Western Territory. For this purpose the Eastern Territory will consist of all territory operating under Eastern and Atlantic Standard Time. All other territory will be known as Western Territory. The location of the official's headquarters will determine whether he is in the Eastern or Western territory.

- (d) The Standing Committees of the Section will be as follows:

- I—Economics of Railway Signaling
- II—Interlocking
- III—Signal Shop Practice
- IV—Automatic Block Signaling
- V—Contracts and Instructions
- VI—Designs
- VII—Materials Research
- VIII—Highway Grade Crossing Protection
- IX—Overhead and Underground Lines
- X—Signaling Practice
- XI—Electronics
- XII—Circuit Design

The representation of Member Roads on these committees will be, when practicable, territorially selected, in approximately the same proportion as that of the Committee of Direction, the personnel to be named each year by the Committee of Direction.

Duties of Officers

5. The CHAIRMAN shall have general supervision over the affairs of the Section and shall preside at meetings of the Section and at meetings of the Committee of Direction.
6. The FIRST VICE-CHAIRMAN, in the absence of the Chairman, shall perform the duties of the Chairman. He shall perform such other duties as may be assigned to him by the Chairman.
7. The SECOND VICE-CHAIRMAN, in the absence of both the Chairman and First Vice-Chairman, shall perform the duties of the Chairman. He shall perform such other duties as may be assigned to him by the Chairman.
8. (a) The SECRETARY shall devote his entire time to the work of the Section and will perform the usual duties of that office and such other duties as may be assigned to him by the Chairman.
(b) He shall receive on or before November 20th of each year the report of the Committee on Nominations, as elsewhere provided for, and will submit to the voting representatives of Member Roads, not later than November 29th, for letter ballot vote, the nominations contained in that report, to fill the vacancies in the membership of the Committee of Direction. He shall appoint three Tellers from representatives of Member Roads to assist him in counting the ballots, who shall certify the count thereof, with him, to the Committee of Direction. He shall announce the result of the ballot to the Members promptly.
(c) He shall furnish, free of charge, to each representative of a Member Road, designated by such road, one copy of all circulars, Advance Notices and Minutes.
(d) He shall furnish to each Railroad Affiliated, Affiliated and Life Member one copy of all circulars, Advance Notices and Minutes.

Duties of Committees

9. The COMMITTEE OF DIRECTION shall:
 - (a) Exercise general supervision over the interests and affairs of the Section.
 - (b) Be empowered to act on behalf of the Section in the interim between meetings and submit at each meeting a report covering its actions.
 - (c) Examine and decide what portion of communications, papers and reports shall be submitted to the meetings. It shall determine which, if any, of the subjects presented by the various committees shall be referred to the General Committee of the Engineering Division.
 - (d) Appoint on or before October 1st of each year a Committee on Nominations consisting of representatives of five Member Roads, who shall not be members of the Committee of Direction.
 - (e) Appoint additional committees as required.
 - (f) Submit to the Vice-President, Operations and Maintenance Department, detail of contemplated financial requirements for conducting the work of the Section as required or as called for by that official.

- (g) Call Annual meetings of the Section if in its judgment conditions warrant.
 - (h) Call meetings of the Section upon not less than thirty days' notice to each member. It MUST call a special meeting of the Section upon the request in writing of a majority of the voting members of Member Roads.
 - (i) Publish Manual of Recommended Practice, in which shall be included such approved Specifications, Drawings, Findings and Conclusions of the Section as the Committee of Direction may find advisable.
10. The COMMITTEE ON NOMINATIONS, appointed as prescribed above, shall report to the Secretary on or before November 20th each year at least two nominations for each impending vacancy to replace the territorial representatives on the Committee of Direction.
- The duties of the Standing Committees shall be as follows:
11. COMMITTEE I—ECONOMICS OF RAILWAY SIGNALING. Study and report on the economy, if any, of the various signal systems, interlocking, train control, cab signals and other signaling projects.
12. COMMITTEE II—INTERLOCKING. Prepare specifications for the various types of interlockings and submit reports on subject-matters relating thereto.
13. COMMITTEE III—SIGNAL SHOP PRACTICE. Study and report on signal shop practices.
14. COMMITTEE IV—AUTOMATIC BLOCK SIGNALING. Prepare specifications for the various types of automatic block systems and submit reports on subject-matters relating thereto.
15. COMMITTEE V—CONTRACTS AND INSTRUCTIONS. Prepare recommended forms for use in connection with signaling contracts and prepare instructions relating to signal maintenance.
16. COMMITTEE VI—DESIGNS. Prepare detailed drawings for standardization purposes and make any special study or investigation assigned to it by the Committee of Direction.
17. COMMITTEE VII—MATERIALS RESEARCH. Make such investigation of materials used in connection with signaling as directed by the Committee of Direction and submit reports on its conclusions.
18. COMMITTEE VIII—HIGHWAY GRADE CROSSING PROTECTION. Prepare requisites for highway grade crossing protection and submit matters of interest relating thereto.
19. COMMITTEE IX—OVERHEAD AND UNDERGROUND LINES. Prepare specifications for overhead and underground lines and any recommendations relating to such lines which will be of interest to the Section.

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20. **COMMITTEE X—SIGNALING PRACTICE.** Prepare requisites for the various types of interlocking and block signaling systems, make recommendations having reference to the signal indications which should be given as the varied conditions on railroads require, also submit reports on such other matters as may be assigned by the Committee of Direction.
21. **COMMITTEE XI—ELECTRONICS.** Investigate and report on the use of electronics in connection with railway signal systems, interlocking, centralized traffic control, and highway grade crossing protection.
22. **COMMITTEE XII—CIRCUIT DESIGN.** Prepare typical circuits representative of approved practices and requisites for railroad signaling.
23. **REPRESENTATION OF THE SECTION UPON GENERAL COMMITTEE OF THE ENGINEERING DIVISION:** The five representatives of the Signal Section upon the General Committee of the Engineering Division shall be the Chairman, First Vice-Chairman, Second Vice-Chairman, and two members of the Committee of Direction to be selected by it.
24. **RECOMMENDED PRACTICES:**

Any definition, nomenclature, specification, recommended construction or recommended practice or any proposition having for its objective the formal declaration of the Section upon any matter of importance shall be presented in writing (accompanied by drawings if the latter are necessary for a clear understanding of the subject).

Such submissions will be presented to the Section at its Annual meeting for discussion, and following vote to decide whether or not the proposition shall be submitted to the voting members of Member Roads for adoption or rejection by letter ballot. If the vote to submit is affirmative, the Secretary within three months from the date of the meeting will distribute the ballots with a copy of the Minutes of the meeting, requesting their return within thirty days, naming the date. Ballots mailed after that date, as shown by the postmark, will not be counted. The Secretary shall announce the result of the ballot promptly to the Members. Ballots and envelopes shall be preserved for at least two years from date of announcement. The voting power of the Member Roads shall be as named in paragraph 26.
25. **VOTING AT MEETINGS OF SECTION:** Vote may be taken viva voce, by rising, by roll call or by ballot. Each Member Road shall be entitled to one vote, the ranking officer of a road present at any meeting being recognized as the voting representative of that road, unless otherwise designated by it. The vote of a majority of the Member Roads represented shall be required to decide any question, motion or resolution unless otherwise ordered, except that in the consideration of submitting a question to the letter ballot vote of the Member Roads, all representatives of Member Roads present at any meeting may vote. Thirty representatives of Member Roads shall constitute a quorum.

26. LETTER BALLOTS:

Letter ballots may be taken upon any subject by order of the Committee of Direction and *must* be taken on all questions affecting physical property. The voting power of the Member Roads shall be proportionate to ownership of signal equipment, one vote being counted for each

- 400 signals operating in two positions;
- 250 signals operating in three or four positions;
- 200 interlocked switches, power operated;
- 400 interlocked switches, manually operated;
- 250 highway crossings, automatically protected;
- 1600 train control inductors or loop circuits;
- 800 train control ramp (energized) magnet or coded circuits.

A fraction of a vote in the total of all items, if greater than one-half, shall be counted as one. Each Member Road shall have at least one vote.

Any proposition for which a majority of the votes are affirmative, shall be considered adopted.

27. ORDER OF BUSINESS: The order of business at meetings of the Section shall, unless otherwise directed by a majority of the members present, be as follows:

- Approval of Minutes of Last Meeting;
- Reports of Standing Committees;
- Reports of Special Committees;
- Unfinished Business;
- New Business.

28. Roberts' Rules of Order shall govern the proceedings of the Section, including amendment of these Rules of Order.

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RESULT OF LETTER BALLOT ON SUBJECTS APPROVED AT THE
ANNUAL MEETING, SEPTEMBER 18, 19 AND 20, 1950

All subjects submitted to letter ballot were unanimously approved,
as follows:

	For	Against
<i>Committee II—Interlocking</i>		
Specification 152-50—Electro-Pneumatic Switch Operating Mechanism. (Superseding Specification 152-43, Manual Part 30.)	1022	0
Specification 101-50—Electric Motor Switch Operating Mechanism. (Superseding Specification 101-43, Manual Part 104.)	1022	0
A.A.R. Sig. Sec. 1457C—Load Requirement for Power-Operated Switch Mechanism. (Superseding A.A.R. Sig. Sec. 1457B in the Manual.)	1022	0
<i>Committee III—Signal Shop Practice</i>		
Requisites for Containers for Shipping Relays and Similar Apparatus. (New.)	1022	0
<i>Committee IV—Automatic Block Signaling</i>		
Specification 135-50—Track Circuit Bonding. (Superseding Specification 135-42, Manual Part 22.)	1022	0
Specification 151-50—Plug Type Rail Bonds and Track Circuit Connectors. (Superseding Specification 151-49, Manual Part 112.)	1022	0
A.A.R. Sig. Sec. 1047B—Welded Type Rail Head Bonds and Track Circuit Connectors. (Superseding A.A.R. Sig. Sec. 1047A in the Manual.)	1022	0
A.A.R. Sig. Sec. 1631E—Single Conductor Plug Type Rail Bonds and Track Circuit Connectors. (Superseding A.A.R. Sig. Sec. 1631D in the Manual.)	1022	0
A.A.R. Sig. Sec. 1632E—Duplex Conductor Plug Type Rail Bonds and Track Circuit Connectors. (Superseding A.A.R. Sig. Sec. 1632D in the Manual.)	1022	0
Requisites for Track Welding or Heat Treating in Track Circuit Territory. (Superseding Requisites for Track Welding or Heat Treating in Track Circuit Territory, Manual Part 156.)	1022	0
Requisites for Minimizing the Effect of Foreign Current on Direct Current Track Circuits. (Superseding Requisites for Minimizing the Effect of Foreign Current on Direct Current Track Circuits, Manual Part 127.)	1022	0
Specification 199-50—Electric Motor Mechanism and Gate Arm for Highway Grade Crossing Signal. (Superseding sections 8-a, 8-b, 8-c, 10-a, 10-b, 10-c, 11-h, 20-a-2 and 20-a-3 of Specification 199-44, Manual Part 194.)	1022	0

	For	Against
<i>Committee IV—Automatic Block Signaling—Continued</i>		
Specification 160-50—Capacitor for Power Factor Improvement. (Superseding Specification 160-39, Manual Part 100.)	1022	0
Specification 78-50—Alternating Current Induction Type Relay. (Superseding Specification 78-39, Manual Part 122.)	1022	0
Specification 162-50—Color Position Light Signal. (Superseding Specification 162-43, Manual Part 50.)	1022	0
Specification 157-50—Color Light Signal, Searchlight Type. (Superseding sections 18-a, 19-a and 19-b of Specification 157-45, Manual Part 93.)	1022	0

<i>Committee V—Contracts and Instructions</i>		
Definitions for Technical Terms Used in Signaling. (To be included in Manual Part 55.)	1022	0
Instructions for Non-Coded Direct Current Track Circuits. (Superseding Instructions for Non-Coded Direct Current Track Circuits, Manual Part 8.)	1022	0
A.A.R. Sig. Sec. 1662D—Graphical Symbols—Tracks and Highway Crossings. (Superseding A.A.R. Sig. Sec. 1662C in the Manual.)	1022	0
A.A.R. Sig. Sec. 1673E—Graphical Symbols—Relays. (Superseding A.A.R. Sig. Sec. 1673D (Three Sheets) in the Manual.)	1022	0
A.A.R. Sig. Sec. 1674F (Three Sheets)—Graphical Symbols—Relay Contacts. (Superseding A.A.R. Sig. Sec. 1674E (Three Sheets) in the Manual.)	1022	0
A.A.R. Sig. Sec. 1680C (Two Sheets)—Graphical Symbols—Circuit Appurtenances. (Superseding A.A.R. Sig. Sec. 1680B in the Manual.)	1022	0

<i>Committee VI—Designs</i>		
Specifications for Bolts, Nuts and Threads. (Superseding Specification for Bolts, Nuts and Threads, Manual Part 17.)	1022	0
A.A.R. Sig. Sec. 1642E—Railroad Crossing Sign—90 Degree Reflector Type for 4 to 8-Inch Pipe—Assembly. (Superseding A.A.R. Sig. Sec. 1642D in the Manual.)	1022	0
A.A.R. Sig. Sec. 1643E—Front Plates for Railroad Crossing Sign—90 Degree Reflector Type—Details. (Superseding A.A.R. Sig. Sec. 1643D in the Manual.)	1022	0
A.A.R. Sig. Sec. 1646D—Stop on Red Signal Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly. (Superseding A.A.R. Sig. Sec. 1646C in the Manual.)	1022	0
A.A.R. Sig. Sec. 1648D—Stop When Swinging Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly. (Superseding A.A.R. Sig. Sec. 1648C in the Manual.)	1022	0

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	For	Against
<i>Committee VI—Designs—Continued</i>		
A.A.R. Sig. Sec. 1692C—Railroad Crossing Sign—50 Degree Reflector Type for 4 to 8-Inch Pipe—Assembly. (Superseding A.A.R. Sig. Sec. 1692B in the Manual.)	1022	0
A.A.R. Sig. Sec. 1693D—Front Plates for Railroad Crossing Sign—50 Degree Reflector Type—Details. (Superseding A.A.R. Sig. Sec. 1693C in the Manual.)	1022	0
A.A.R. Sig. Sec. 1489D—Highway Crossing Signal—Flashing Light Type with Suspended Lights and Mast Mounted Gate—Assembly. (Superseding A.A.R. Sig. Sec. 1489C in the Manual.)	1022	0
A.A.R. Sig. Sec. 1462A—Highway Crossing Signal—Flashing Light Type with Extended Lights and Pedestal Mounted Gate—Assembly. (New.)	1022	0
A.A.R. Sig. Sec. 1463A—Cross-Arm for Extended Lights—For Flashing Light Highway Crossing Signal with Pedestal Mounted Gate—Assembly. (New.)	1022	0
A.A.R. Sig. Sec. 1464A—Cross-Arm and Brackets for Extended Lights—For Flashing Light Highway Crossing Signal—Details. (New.)	1022	0
A.A.R. Sig. Sec. 1465A—Extension Bracket—For Highway Crossing Signs. (New.)	1022	0
A.A.R. Sig. Sec. 1493A—Highway Crossing Gate Roadway Arm—For Pedestal Mounting. (New.)	1022	0
A.A.R. Sig. Sec. 1494A—Highway Crossing Gate Sidewalk Arm—For Pedestal Mounting. (New.)	1022	0
A.A.R. Sig. Sec. 1488A—"No Right Turn" or "No Left Turn" Signal—Assembly. (New.)	1022	0
A.A.R. Sig. Sec. 1701A—Back Plates for Railroad Crossing Sign—90 Degree Reflector Type—Details. (New.)	1022	0
A.A.R. Sig. Sec. 1702A—Front and Back Plates for Stop on Red Signal Sign—Reflector Type—Details. (New.)	1022	0
A.A.R. Sig. Sec. 1703A—Front and Back Plates for Stop When Swinging Sign—Reflector Type—Details. (New.)	1022	0
A.A.R. Sig. Sec. 1704A—Back Plates for Railroad Crossing Sign—50 Degree Reflector Type—Details. (New.)	1022	0
A.A.R. Sig. Sec. 1468A—Cross-Arm for Suspended Lights—For Flashing Light Highway Crossing Signal with Mast Mounted Gate—Assembly. (New.)	1022	0
A.A.R. Sig. Sec. 1469A—Brackets for Suspended Lights—For Flashing Light Highway Crossing Signal—Details. (New.)	1022	0
Specification 190-50—Electric Light Unit for Highway Crossing Signal—Reflector Type. (Superseding sections 6-d, 6-i and 6-m of Specification 190-49, Manual Part 166.)	1022	0

	For	Against
<i>Committee VI—Designs—Continued</i>		
Specification 232-50—Electric Light Unit for Highway Crossing Signal—Doublet Lens Type. (Superseding sections 6-c, 6-h, 6-k-2, 6-l, 6-m and 6-n of Specification 232-48, Manual Part 244.)	1022	0
Specification 231-50—"No Right Turn"—"No Left Turn" Illuminated Sign. (Superseding sections 1-a and 6-a of Specification 231-47, Manual Part 237.)	1022	0
<i>Committee VII—Materials Research</i>		
Specification 201-50—Primer Paint, Red Lead Base, for Steel and Iron Structures. (Superseding Specification 201-43, Manual Part 65.)	1022	0
Specification 120-50—Paint and Painting. (Superseding section 9-1 of Specification 120-48, Manual Part 110.)	1022	0
Specification 46-50—Transformer Oil. (Superseding Specification 46-41, Manual Part 108.)	1022	0
Specification for Gray Iron Castings. (Superseding Specification for Gray Iron Castings, Manual Part 88.)	1022	0
Specification for Malleable Iron Castings. (Superseding Specification for Malleable Iron Castings, Manual Part 89.)	1022	0
Specifications for Various Types of Non-Ferrous Metals and Alloys. (Superseding Specifications for Various Types of Non-Ferrous Metals and Alloys, Manual Part 220.)	1022	0
Specification for Signal Colors Exclusive of Signal Glasses. (New.)	1022	0
<i>Committee VIII—Highway Grade Crossing Protection</i>		
Requisites for Control of Automatic Highway Grade Crossing Signals and Devices. (New.)	1022	0
Requisites for Automatic Gates—Highway Crossings at Grade Over Railroad Tracks. (Superseding Requisites for Automatic Gates—Highway Crossings at Grade Over Railroad Tracks, Manual Part 35.)	1022	0
Requisites for Highway Grade Crossing Signals. (Superseding Requisites for Highway Grade Crossing Signals, Manual Part 148.)	1022	0
Requisites for "No Right Turn" and "No Left Turn" Signals for Highway Crossings at Grade Over Railroad Tracks. (Superseding Requisites for "No Right Turn" and "No Left Turn" Signs for Highway Crossings at Grade Over Railroad Tracks, Manual Part 224.)	1022	0
Specification 209-50—Highway Grade Crossing Automatic Gates. (Superseding Specification 209-44, Manual Part 179.)	1022	0

	For	Against
<i>Committee IX—Overhead and Underground Lines</i>		
Specification 145-50—Single and Multiple-Conductor, Insulated, Lead-Covered Parkway Cable, Armored with Flat Steel or Zinc Tape. (Superseding section 7-e of Specification 145-48, Manual Part 20.).....	1022	0
Specification 89-50—Multiple-Conductor Insulated Cable with Weather-Resistant or Flame-Retarding Moisture-Resistant Braid Covering. (Superseding section 7-e of Specification 89-48, Manual Part 25.).....	1022	0
Specification 90-50—Multiple-Conductor Insulated Submarine Cable, Lead Sheathed and Round Steel Armored. (Superseding section 7-d of Specification 90-48, Manual Part 26.).....	1022	0
Specification 91-50—Single and Multiple-Conductor Insulated Lead Sheathed Cable. (Superseding section 7-e of Specification 91-48, Manual Part 28.).....	1022	0
Specification 161-50—Single and Multiple-Conductor, Insulated, Non-Metallic Sheathed Cable. (Superseding sections 7-e and 13 of Specification 161-48, Manual Part 36.).....	1022	0
Specification 111-50—Single-Conductor Insulated Wire and Cable with Flame Retarding, Moisture-Resistant or Weather-Resistant Braid Covering or Outer Polychloroprene Sheath. (Superseding alternate requisites section R-7-a-2 of Specification 111-48, Manual Part 186.).....	1022	0
Specification 239-50—Polychloroprene Compound Sheath for Insulated Wire and Cable. (Superseding section 4-a-3 of Specification 239-48, Manual Part 248.).....	1022	0
Specification 240-50—Single and Multiple-Conductor, Insulated, Polychloroprene Compound Sheathed Cable. (Superseding sections 7-e, 9 and alternate requisites section R-6-a of Specification 240-48, Manual Part 249.)....	1022	0

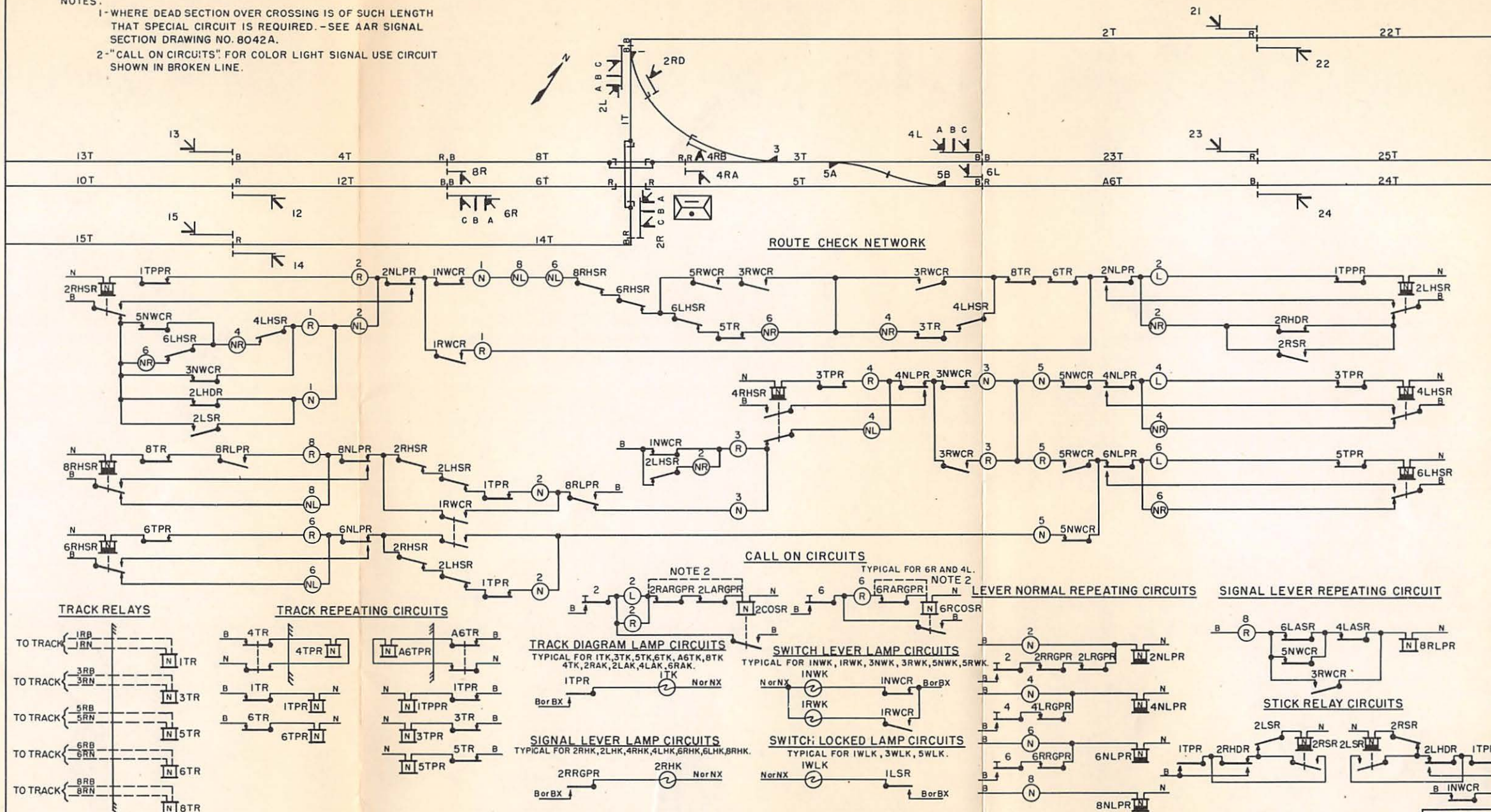
Committee XI—Electronics

Requisites for Electronic Devices and Associated Components for Use in Railway Signaling Systems. (New.).....	1022	0
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NOTES:

1-WHERE DEAD SECTION OVER CROSSING IS OF SUCH LENGTH THAT SPECIAL CIRCUIT IS REQUIRED.-SEE AAR SIGNAL SECTION DRAWING NO. 8042A.

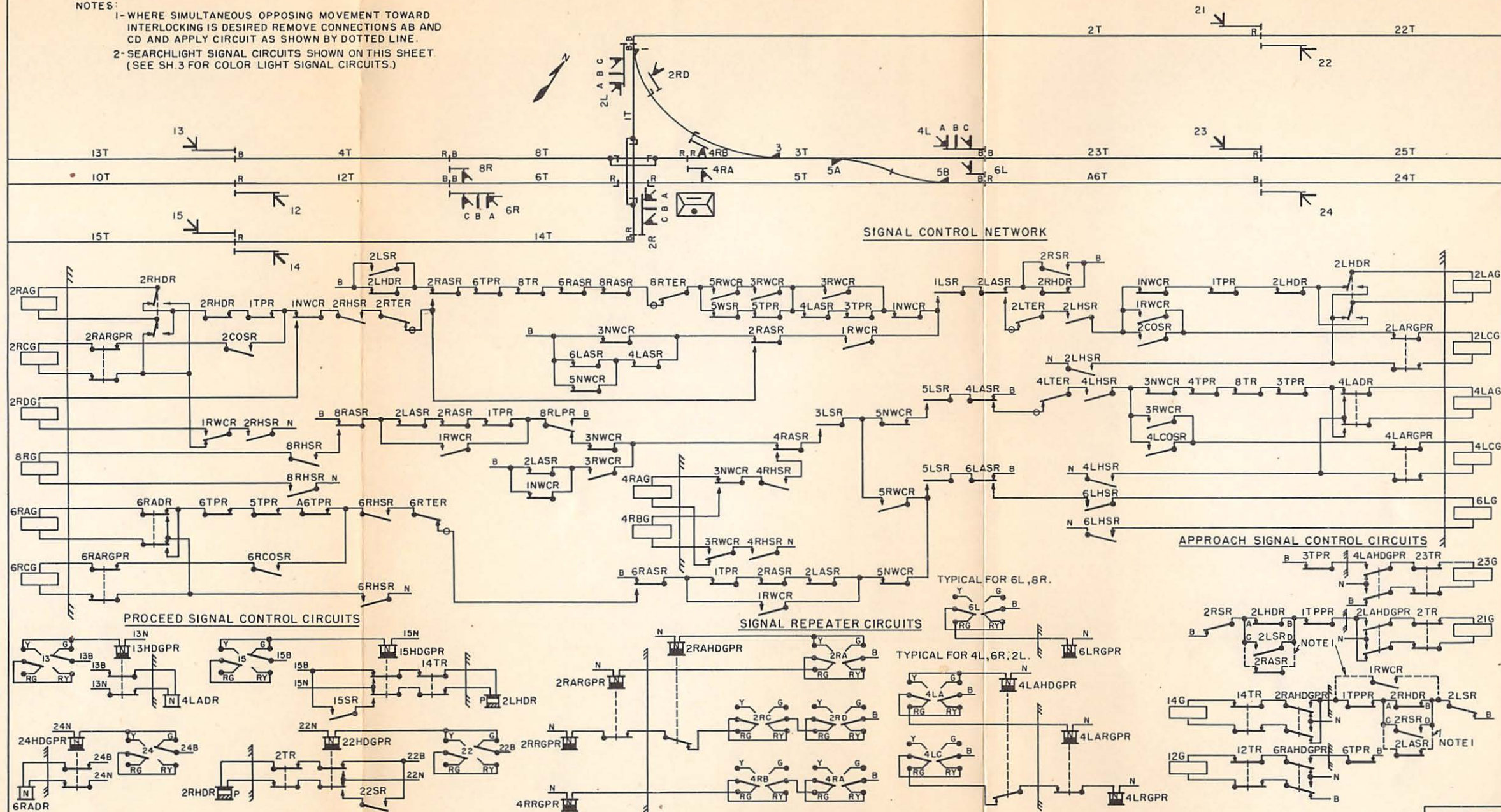
2-"CALL ON CIRCUITS" FOR COLOR LIGHT SIGNAL USE CIRCUIT SHOWN IN BROKEN LINE.



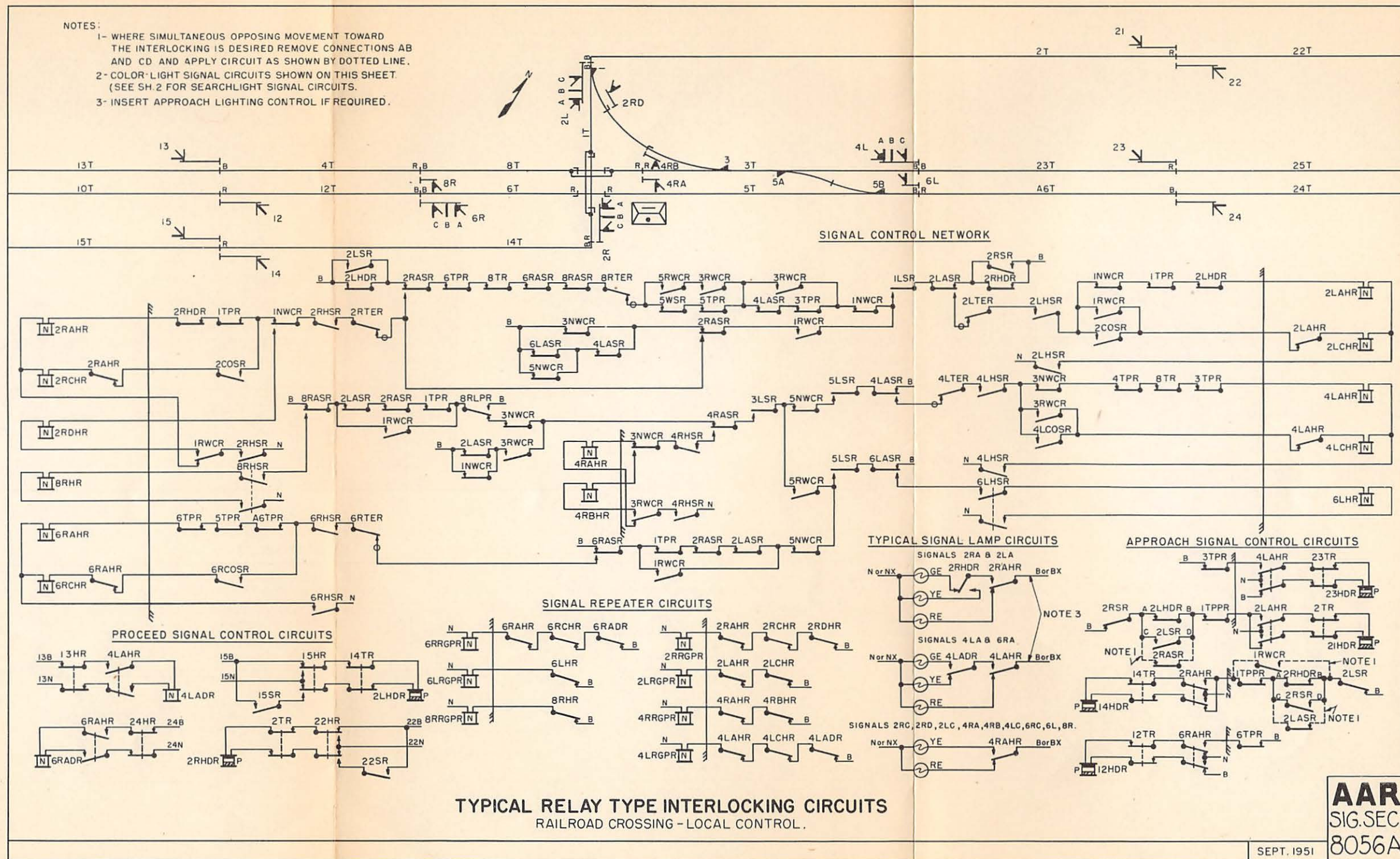
TYPICAL RELAY TYPE INTERLOCKING CIRCUITS
RAILROAD CROSSING -LOCAL CONTROL.

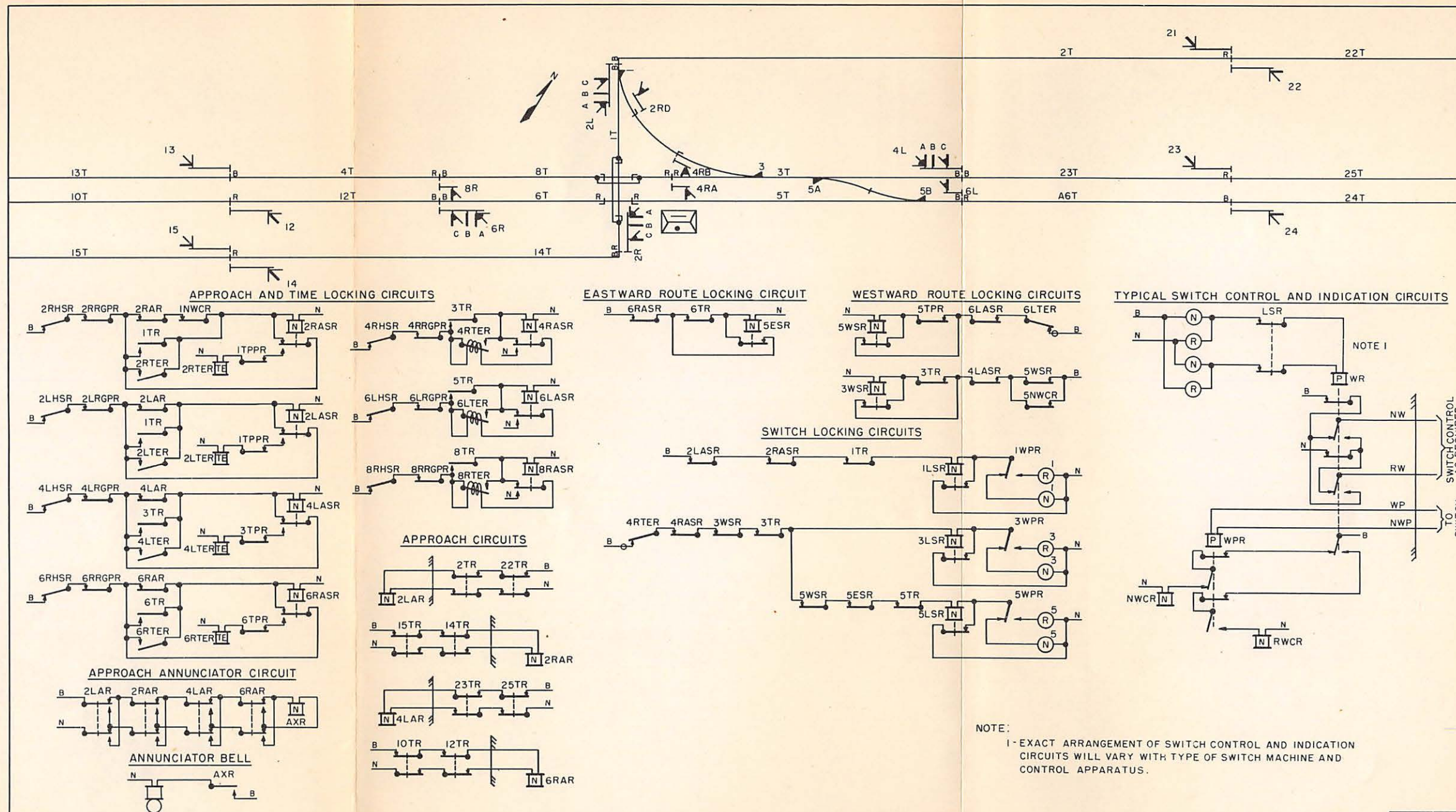
NOTES:

- 1-WHERE SIMULTANEOUS OPPOSING MOVEMENT TOWARD INTERLOCKING IS DESIRED REMOVE CONNECTIONS AB AND CD AND APPLY CIRCUIT AS SHOWN BY DOTTED LINE.
- 2-SEARCHLIGHT SIGNAL CIRCUITS SHOWN ON THIS SHEET. (SEE SH.3 FOR COLOR LIGHT SIGNAL CIRCUITS.)

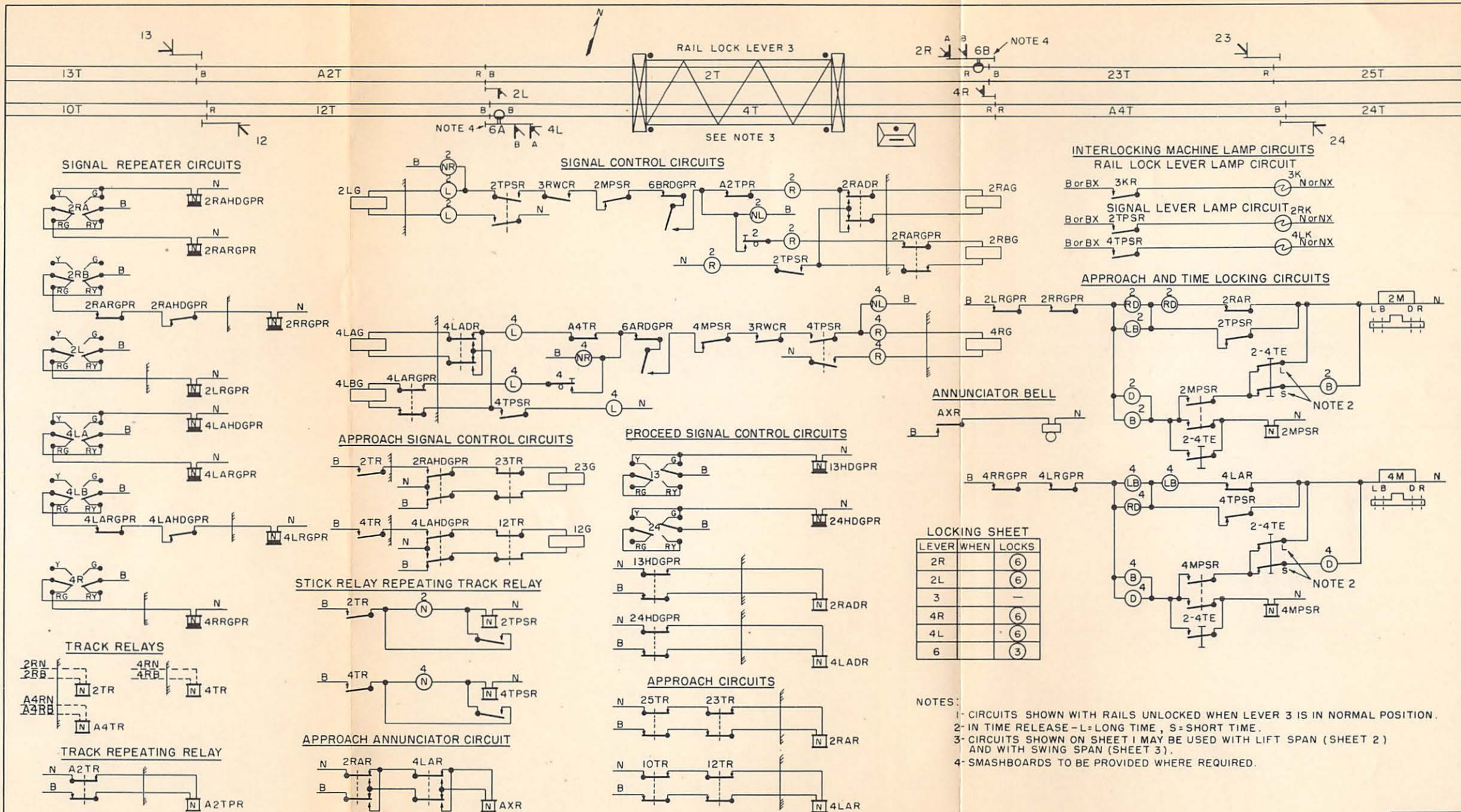


TYPICAL RELAY TYPE INTERLOCKING CIRCUITS



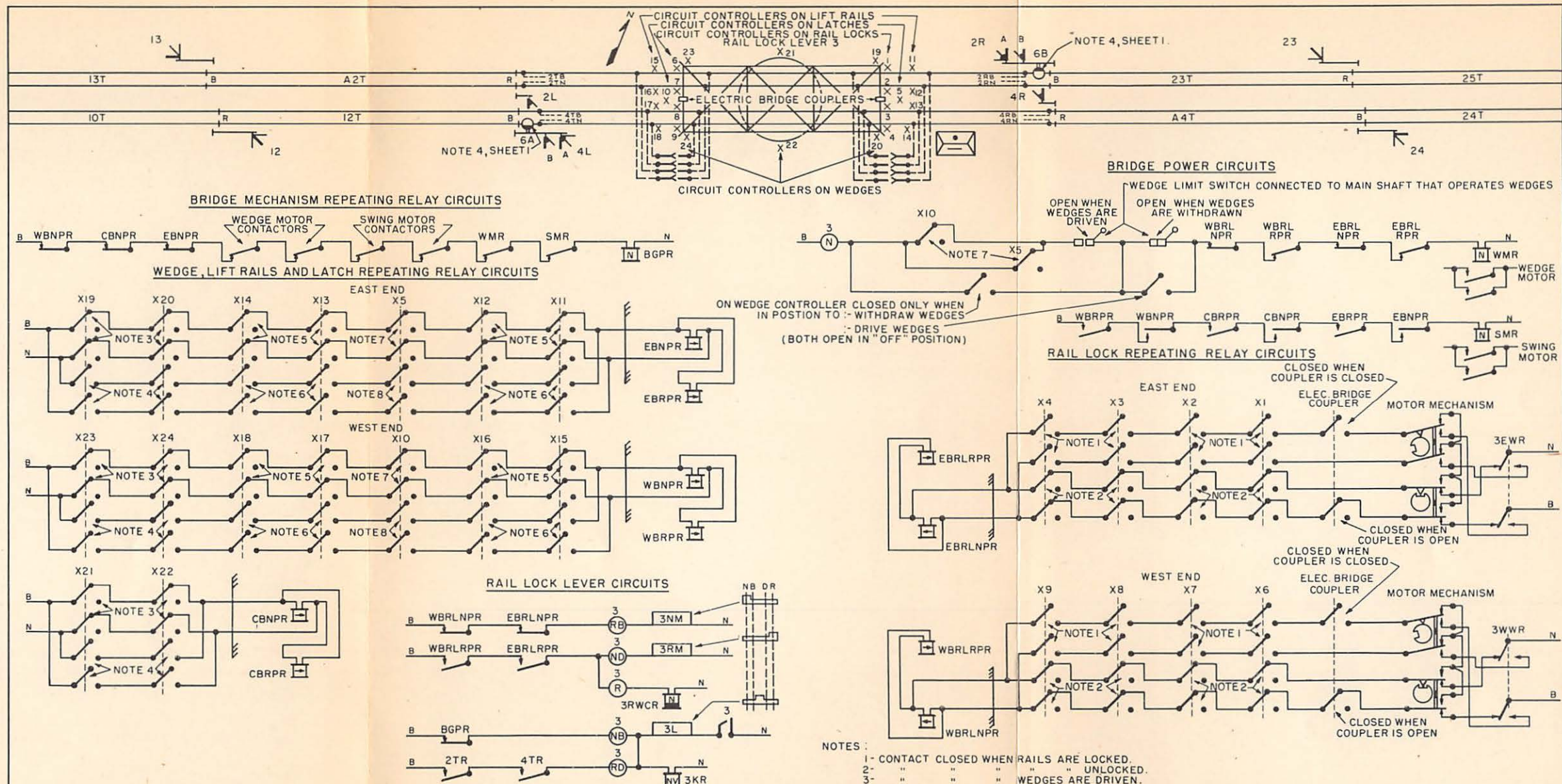


TYPICAL RELAY TYPE INTERLOCKING CIRCUITS
RAILROAD CROSSING - LOCAL CONTROL.

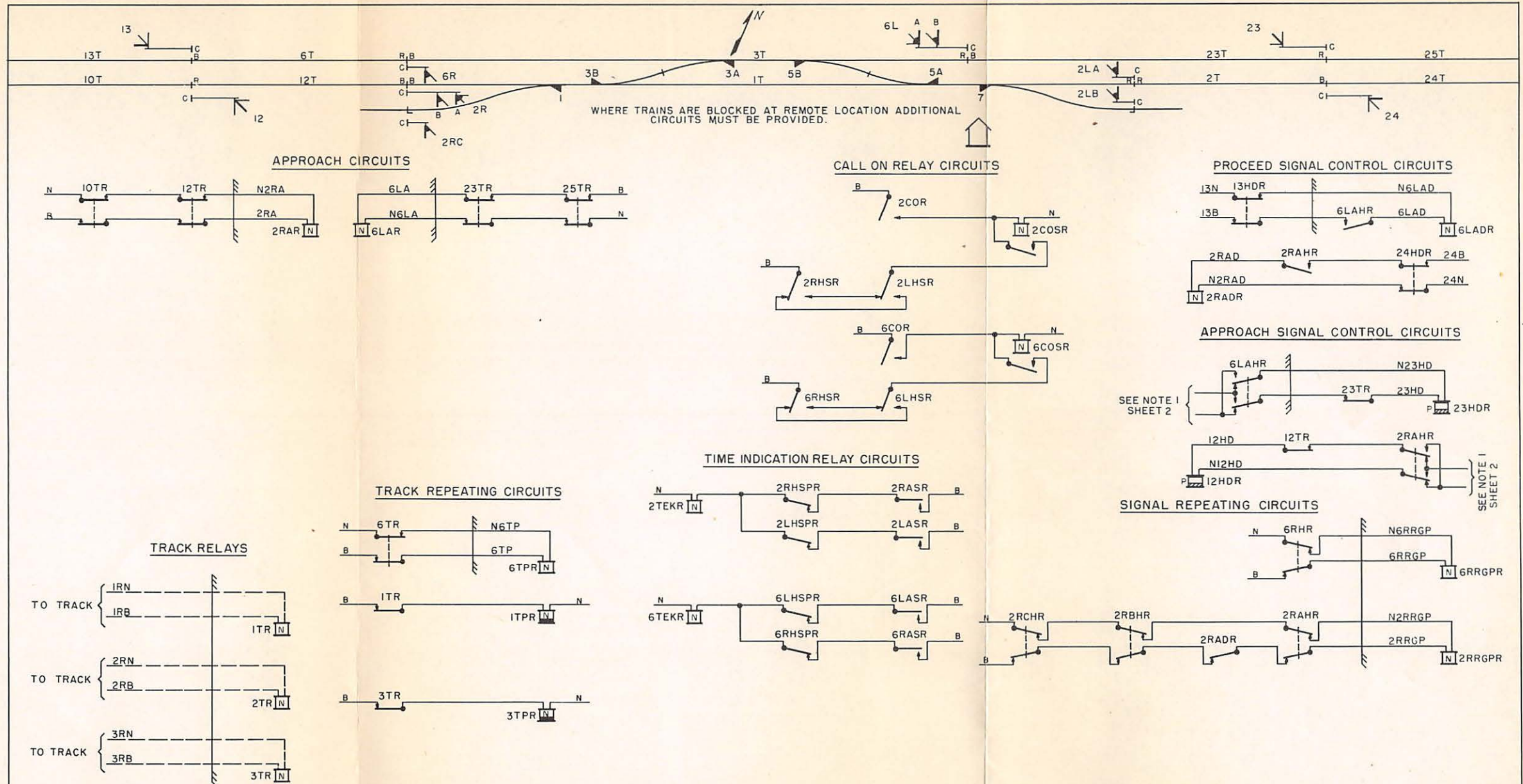


TYPICAL INTERLOCKING CIRCUITS FOR MOVABLE BRIDGE USING MECHANICAL LOCKING.

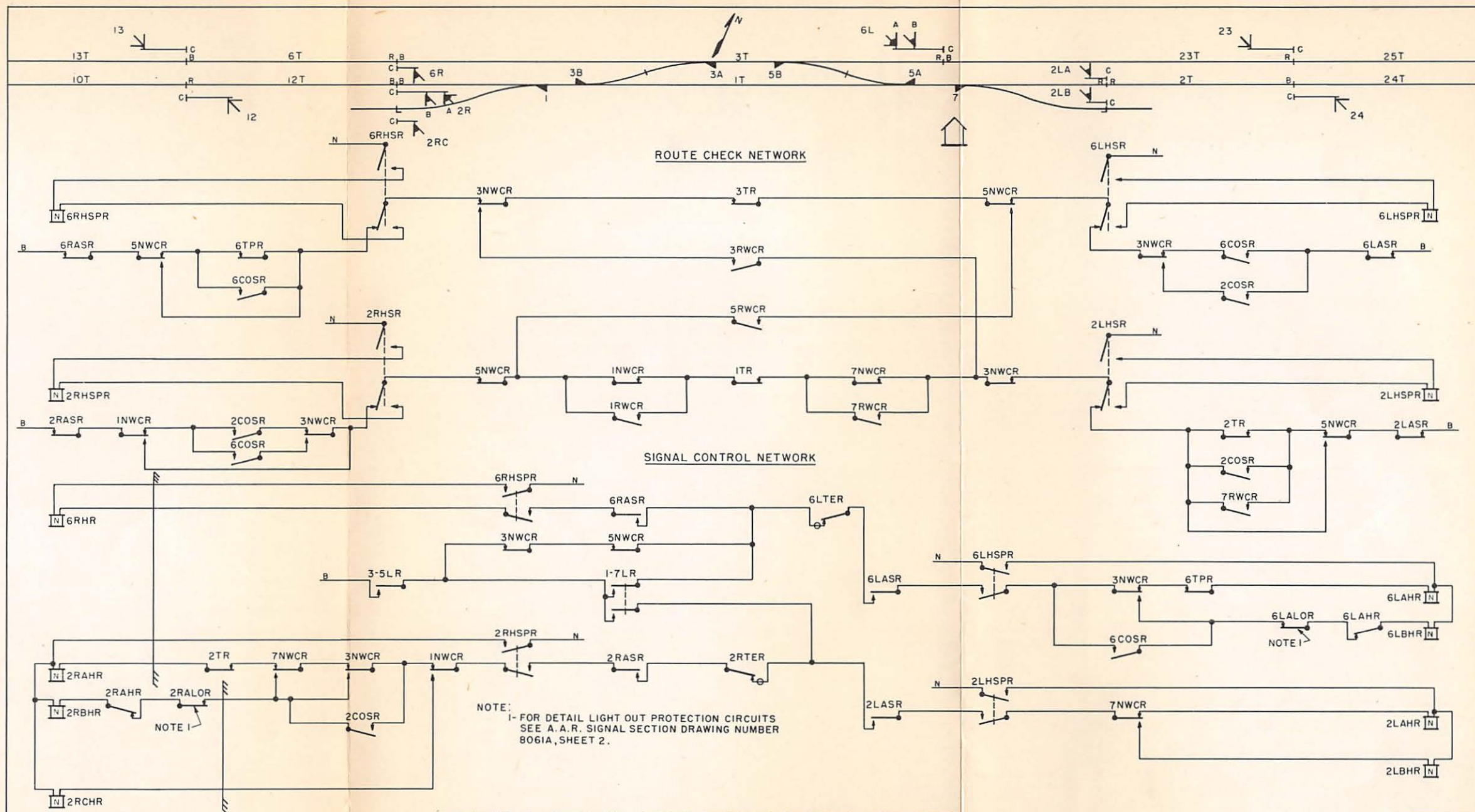




TYPICAL INTERLOCKING CIRCUITS FOR MOVABLE BRIDGE
USING MECHANICAL LOCKING



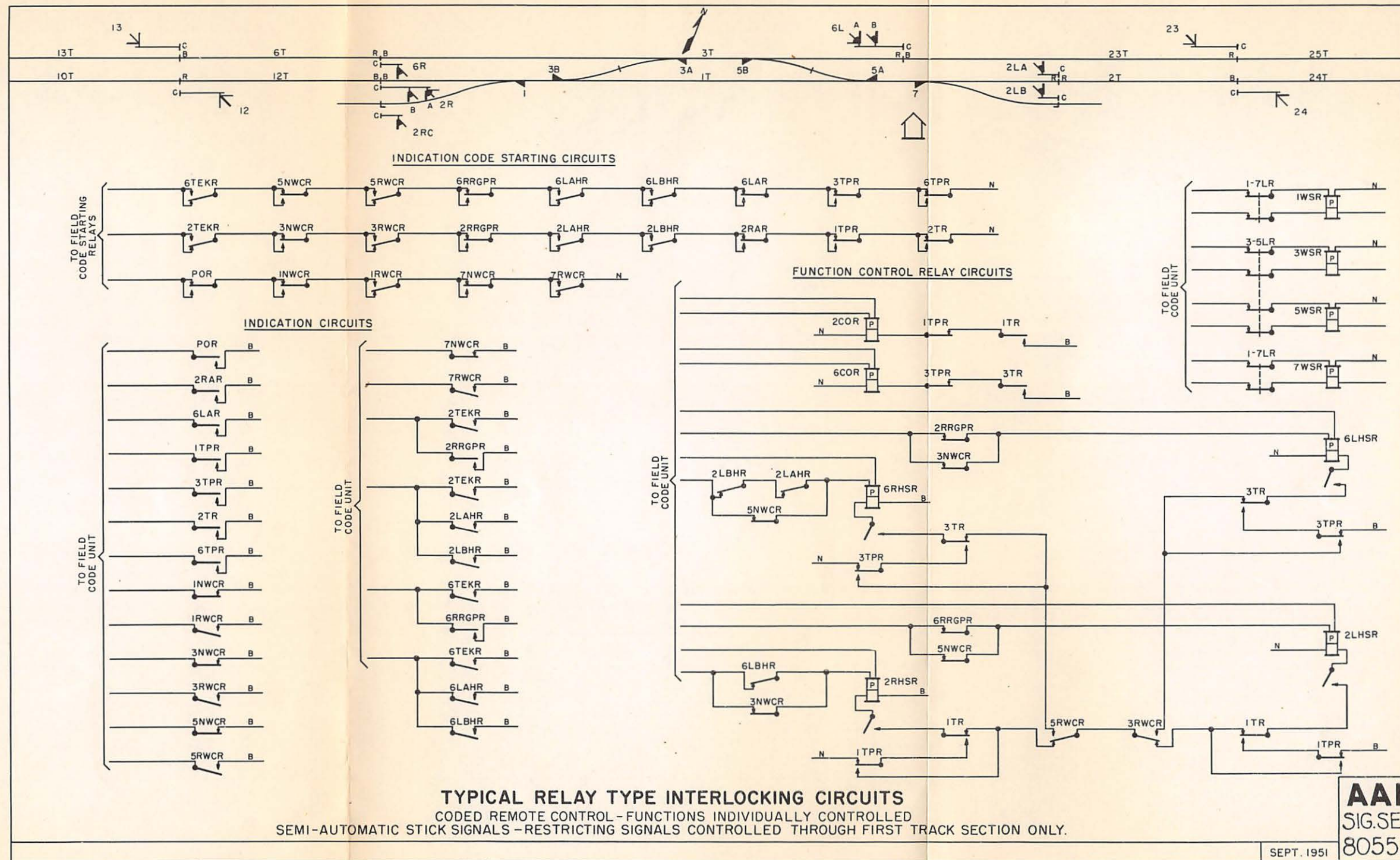
TYPICAL RELAY TYPE INTERLOCKING CIRCUITS
CODED REMOTE CONTROL - FUNCTIONS INDIVIDUALLY CONTROLLED
SEMI-AUTOMATIC STICK SIGNALS - RESTRICTING SIGNALS CONTROLLED THROUGH FIRST TRACK SECTION ONLY.

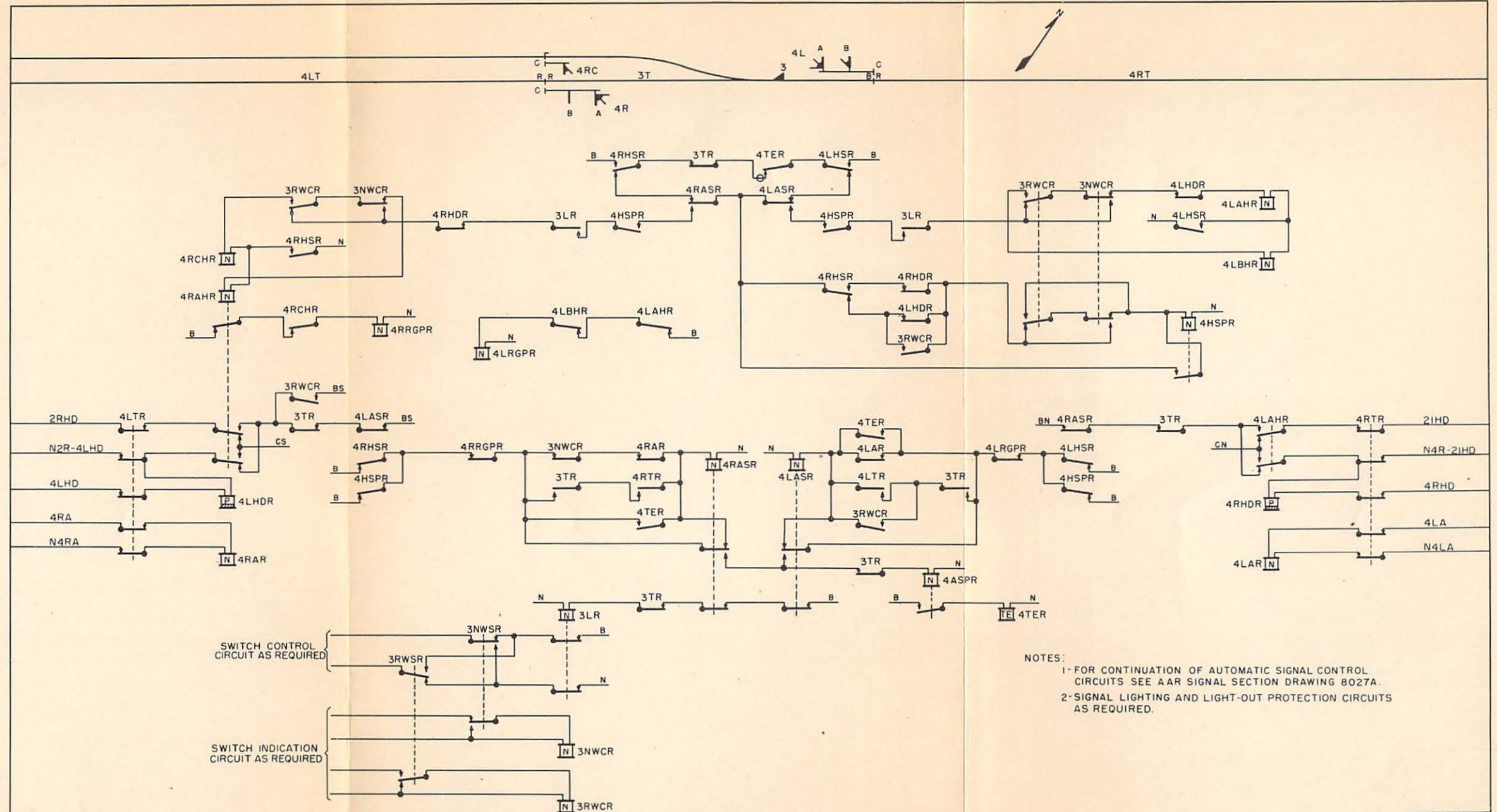


TYPICAL RELAY TYPE INTERLOCKING CIRCUITS

CODED REMOTE CONTROL - FUNCTIONS INDIVIDUALLY CONTROLLED
 SEMI-AUTOMATIC STICK SIGNALS - RESTRICTING SIGNALS CONTROLLED THROUGH FIRST TRACK SECTION ONLY.

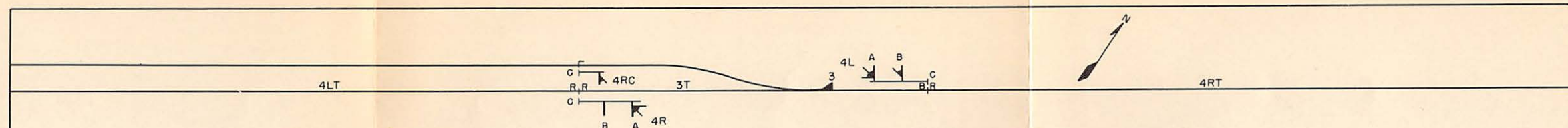




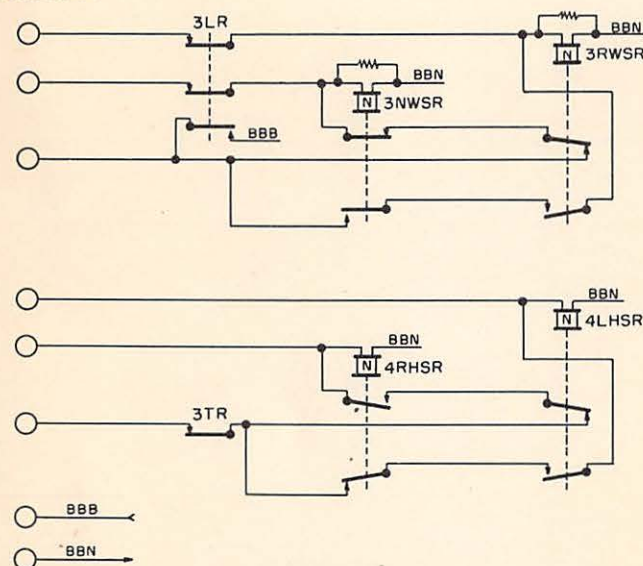


NOTES:
1- FOR CONTINUATION OF AUTOMATIC SIGNAL CONTROL CIRCUITS SEE AAR SIGNAL SECTION DRAWING 8027A.
2- SIGNAL LIGHTING AND LIGHT-OUT PROTECTION CIRCUITS AS REQUIRED.

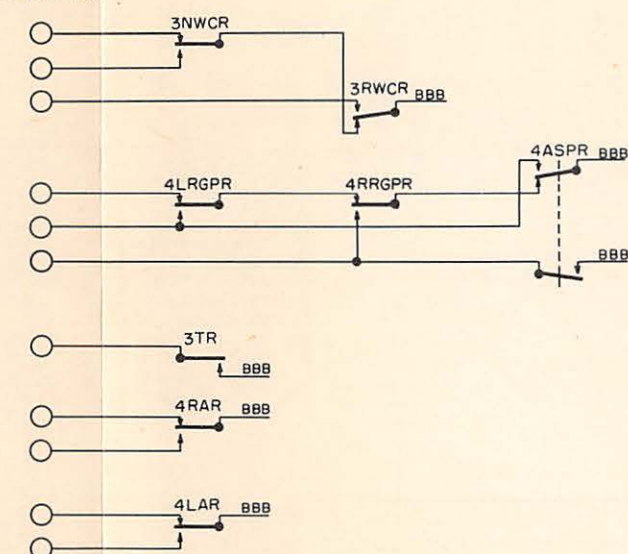
TYPICAL CIRCUITS REMOTE CONTROL SWITCH AND COLORLIGHT SIGNALS
CODE CONTROL USING 3 WIRE HD LINE CIRCUITS



TERMINALS ON
FIELD CODE UNIT



TERMINALS ON
FIELD CODE UNIT

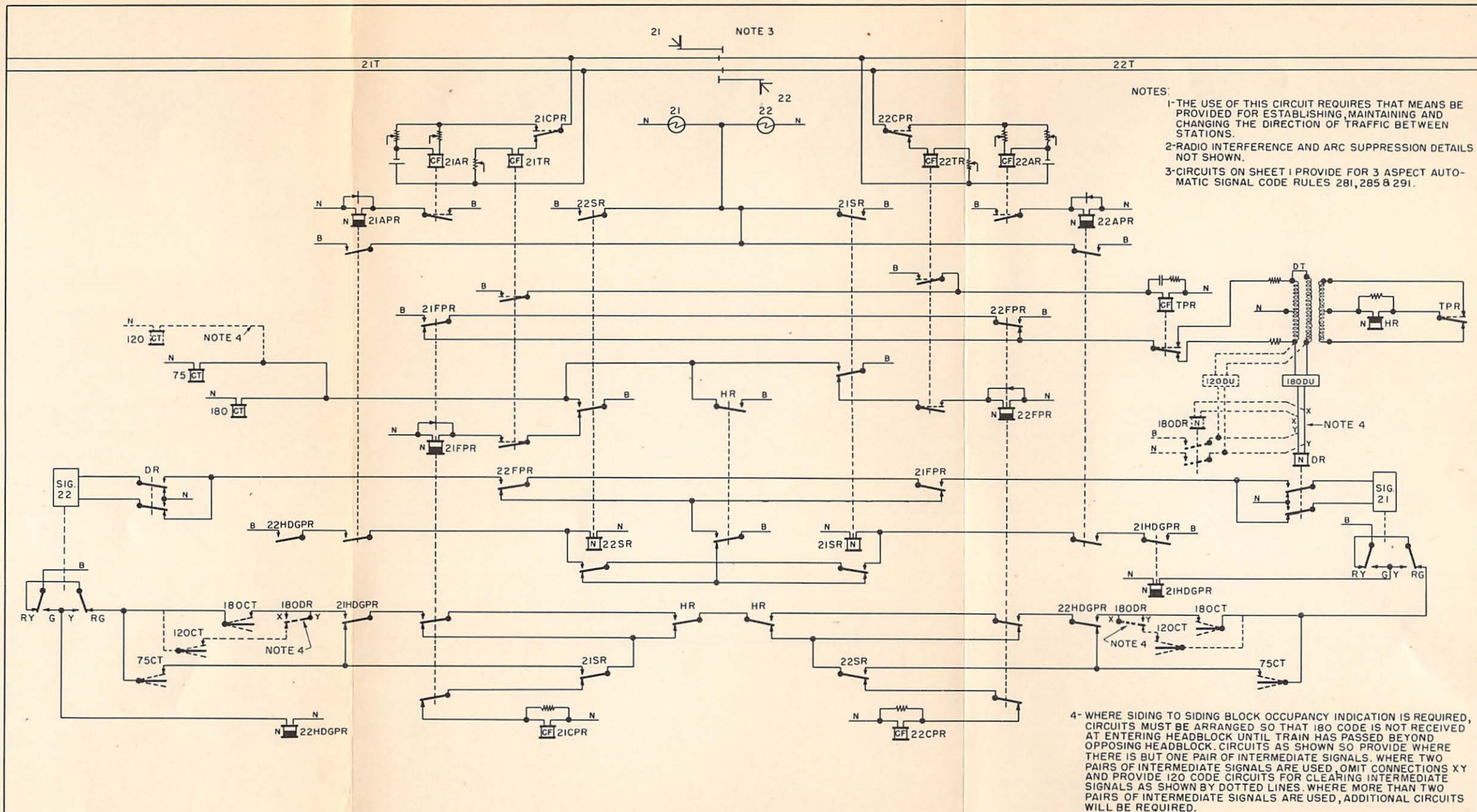


NOTE:
THESE CIRCUITS WILL VARY WITH THE TYPE OF
CODE SYSTEM EMPLOYED.

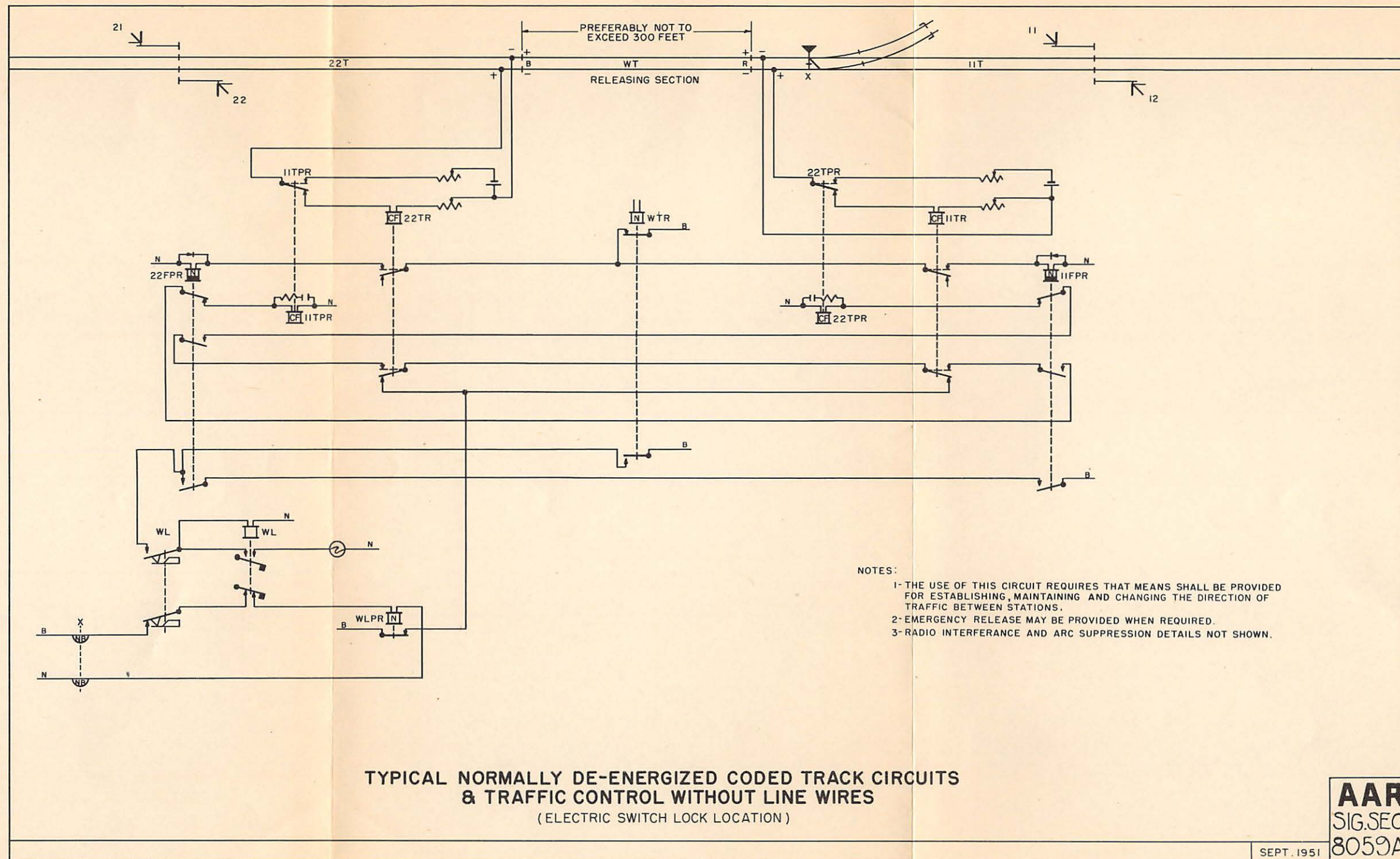
TYPICAL CIRCUITS REMOTE CONTROL SWITCH AND COLORLIGHT SIGNALS CODE CONTROL USING 3 WIRE HD LINE CIRCUITS

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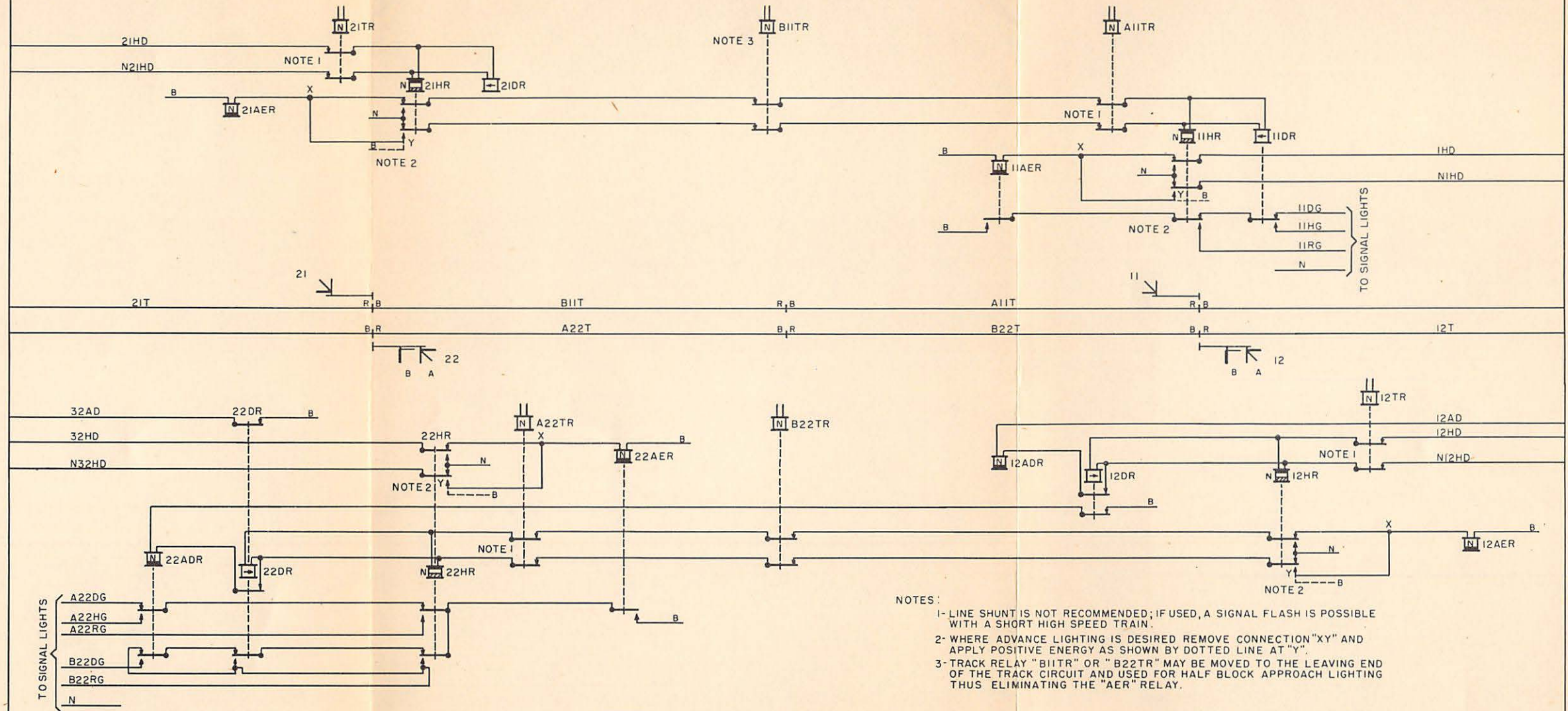
TYPICAL NORMALLY DE-ENERGIZED CODED TRACK CIRCUITS & TRAFFIC CONTROL WITHOUT LINE WIRES



TYPICAL THREE ASPECT COLORLIGHT AUTOMATIC SIGNAL CIRCUITS

USING BIASED NEUTRAL D RELAY AND RETAINED NEUTRAL NEUTRAL H RELAY.

(CODE RULES 281-285-291)



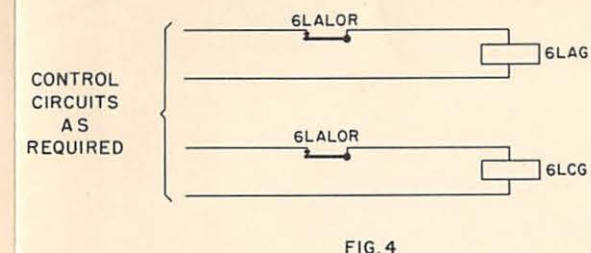
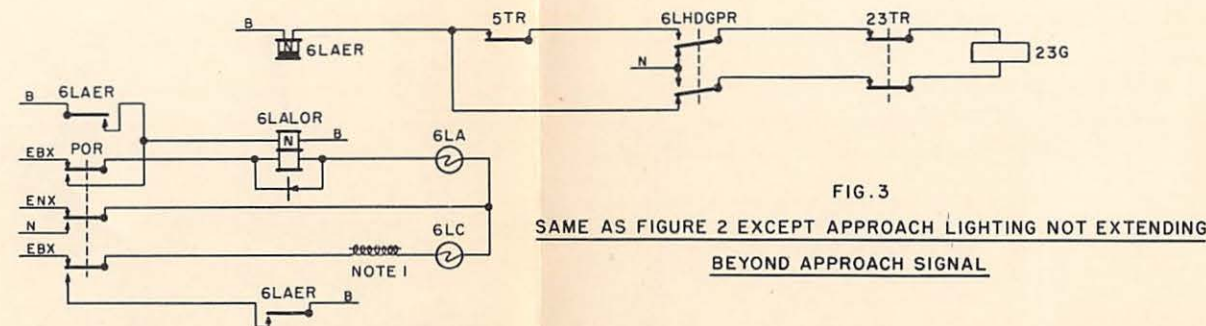
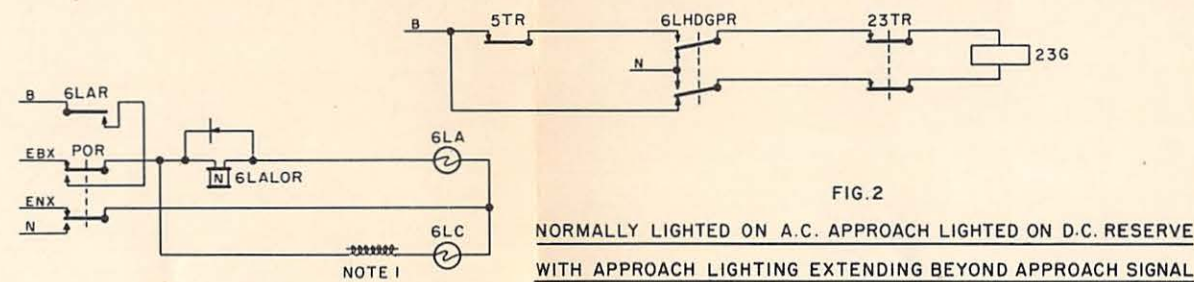
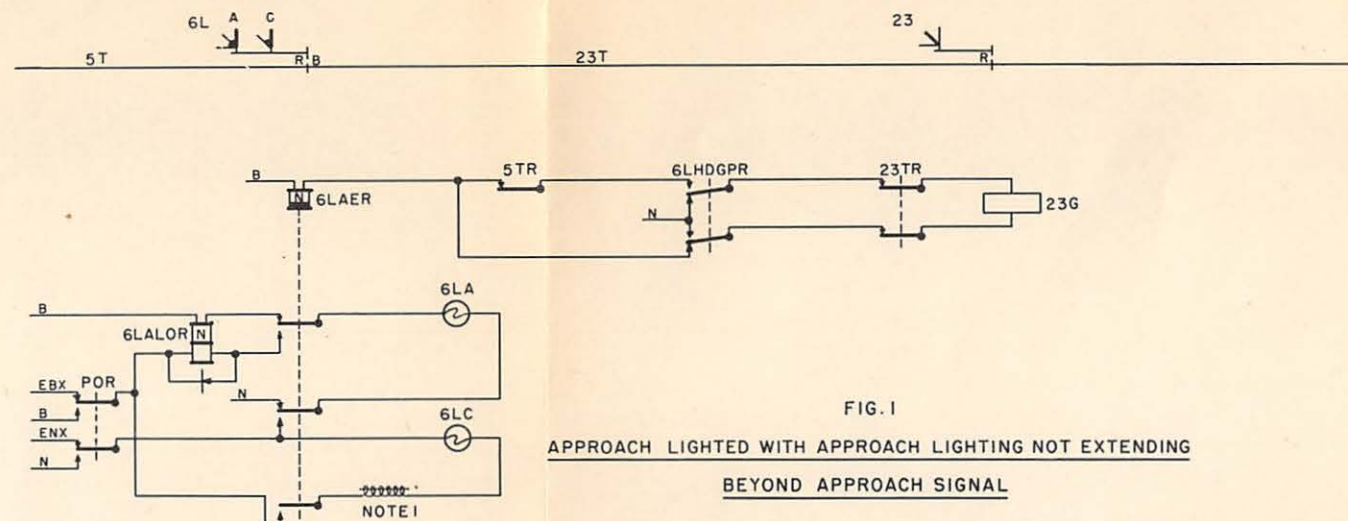
NOTES:

- 1- LINE SHUNT IS NOT RECOMMENDED; IF USED, A SIGNAL FLASH IS POSSIBLE WITH A SHORT HIGH SPEED TRAIN.
- 2- WHERE ADVANCE LIGHTING IS DESIRED REMOVE CONNECTION "XY" AND APPLY POSITIVE ENERGY AS SHOWN BY DOTTED LINE AT "Y".
- 3- TRACK RELAY "BIITR" OR "B22TR" MAY BE MOVED TO THE LEAVING END OF THE TRACK CIRCUIT AND USED FOR HALF BLOCK APPROACH LIGHTING THUS ELIMINATING THE "AER" RELAY.

TYPICAL FOUR ASPECT COLORLIGHT AUTOMATIC SIGNAL CIRCUITS

USING BIASED NEUTRAL D RELAY, RETAINED NEUTRAL NEUTRAL H RELAY AND NEUTRAL SLOW RELEASE AD RELAY.

(CODE RULES 281-282-285-291)



NOTE:
1- THE USE OF REACTOR OR RESISTOR TO COMPENSATE
FOR VOLTAGE DROP ACROSS LOR IN 6LA LAMP CIRCUIT
IS OPTIONAL.

TYPICAL LIGHTOUT PROTECTION CIRCUITS TO PREVENT DISPLAY OF LESS RESTRICTIVE ASPECTS
SEARCHLIGHT TYPE SIGNALS

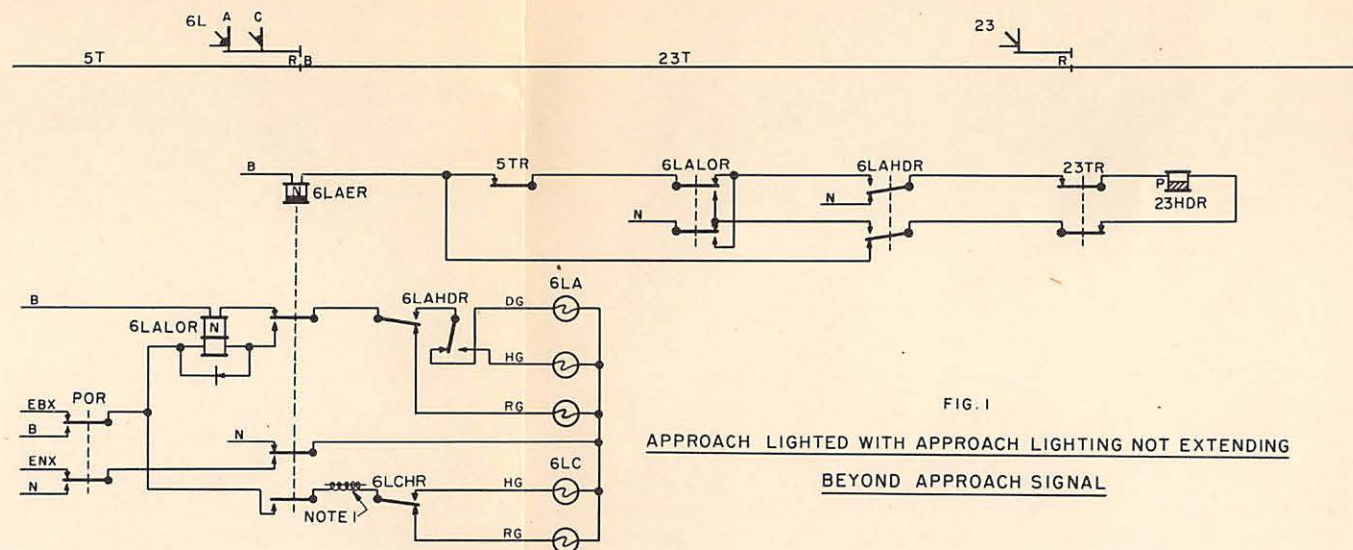


FIG. 1

APPROACH LIGHTED WITH APPROACH LIGHTING NOT EXTENDING
BEYOND APPROACH SIGNAL

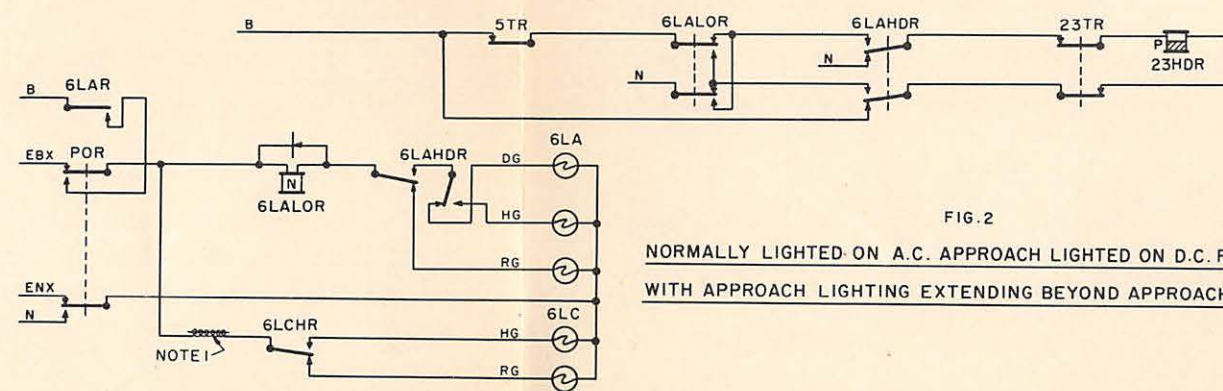


FIG. 2

NORMALLY LIGHTED ON A.C. APPROACH LIGHTED ON D.C. RESERVE
WITH APPROACH LIGHTING EXTENDING BEYOND APPROACH SIGNAL

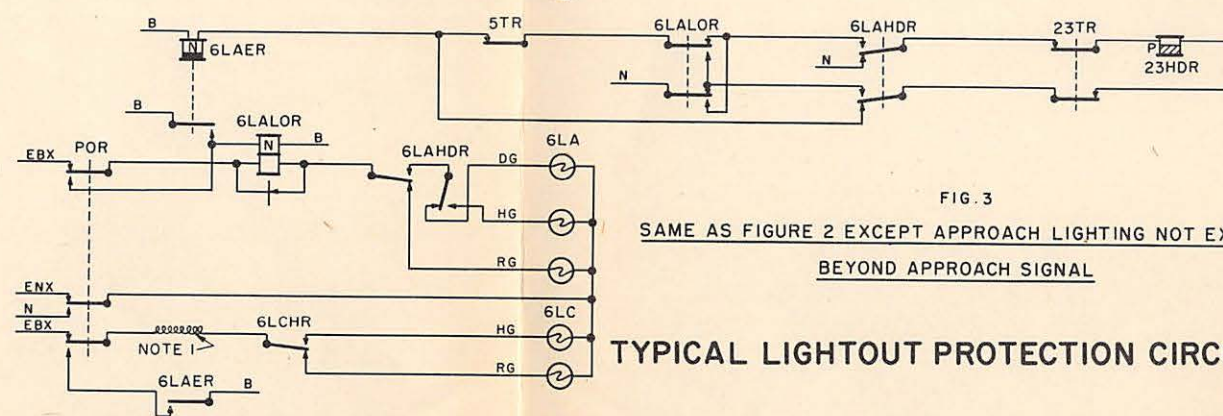


FIG. 3

SAME AS FIGURE 2 EXCEPT APPROACH LIGHTING NOT EXTENDING
BEYOND APPROACH SIGNAL

TYPICAL LIGHTOUT PROTECTION CIRCUITS TO PREVENT DISPLAY OF LESS RESTRICTIVE ASPECTS

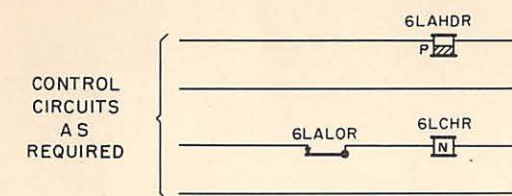
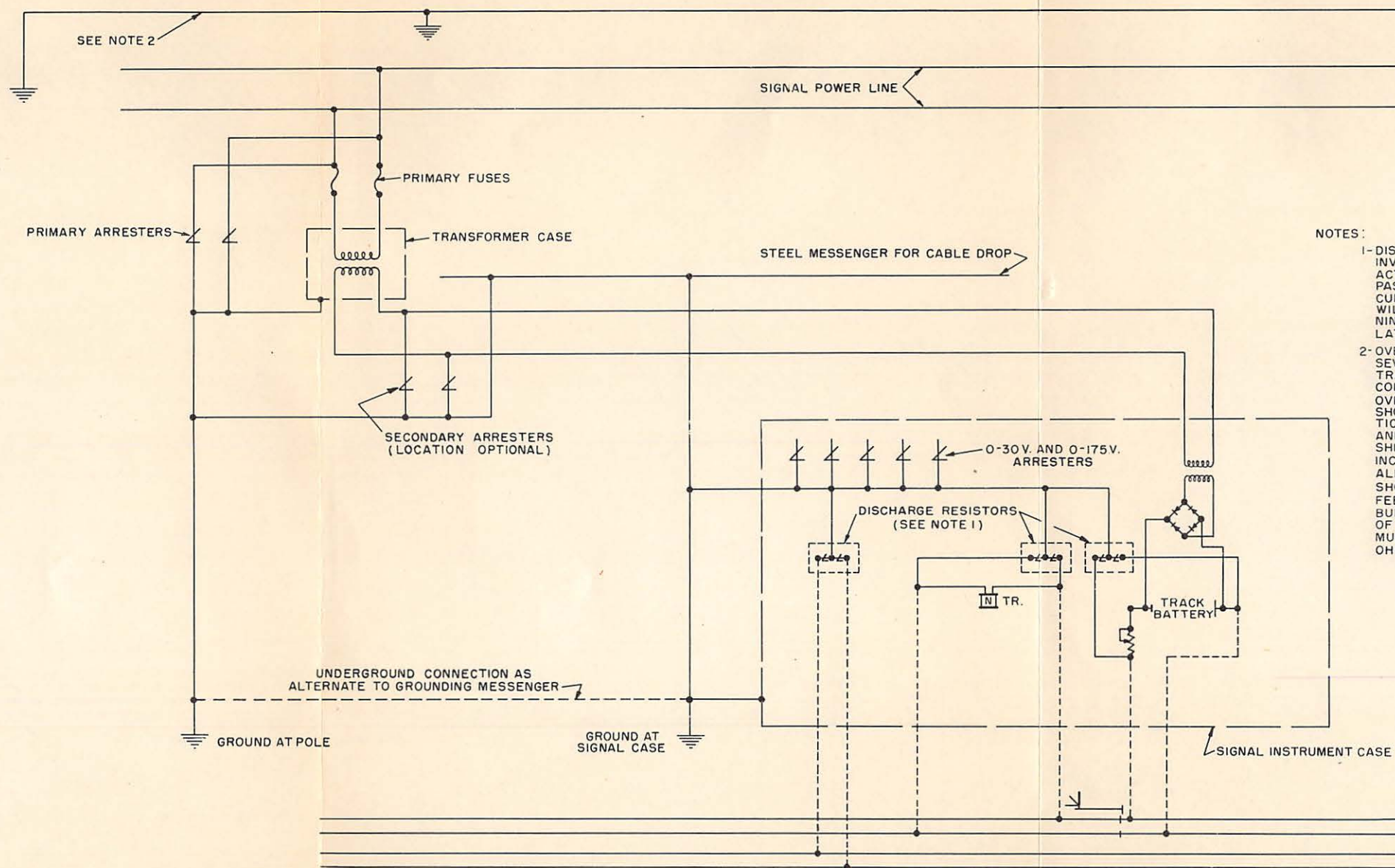


FIG. 4

NOTE:
1- THE USE OF REACTOR OR RESISTOR TO COMPENSATE
FOR VOLTAGE DROP ACROSS LOR IN 6LA LAMP CIRCUIT
IS OPTIONAL.



NOTES:

- 1-DISCHARGE RESISTORS MUST HAVE AN INVERSE RESISTANCE-CURRENT CHARACTERISTIC SO THAT THEY WILL NOT PASS AN APPRECIABLE AMOUNT OF CURRENT AT SIGNAL VOLTAGES BUT WILL PASS LARGE AMOUNTS OF LIGHTNING DISCHARGE CURRENTS WITH RELATIVELY LOW IR DROP.
- 2-OVERHEAD GROUND WIRE EXTENDING SEVERAL POLES EITHER SIDE OF TRANSFORMER LOCATION AND GROUND CONNECTION. OVERHEAD GROUND WIRE OR SHIELD SHOULD HAVE 8 FEET OR MORE VERTICAL CLEARANCE FROM ALL POWER AND SIGNAL WIRES. DOWN LEADS FROM SHIELD WIRE SHOULD HAVE 4 FEET, 3 INCHES OR MORE CLEARANCE FROM ALL OTHER WIRES, AND THE GROUNDS SHOULD NOT BE CLOSER THAN 10 FEET TO ANY OTHER GROUND OR BURIED CONDUCTOR. NET RESISTANCE OF THE SHIELD WIRE GROUNDS IN MULTIPLE SHOULD NOT EXCEED 4 OHMS.

TYPICAL CIRCUITS FOR LIGHTNING PROTECTION

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SIGNAL SECTION, A.A.R.

ADVANCE NOTICE

September 10, 11 and 12, 1951